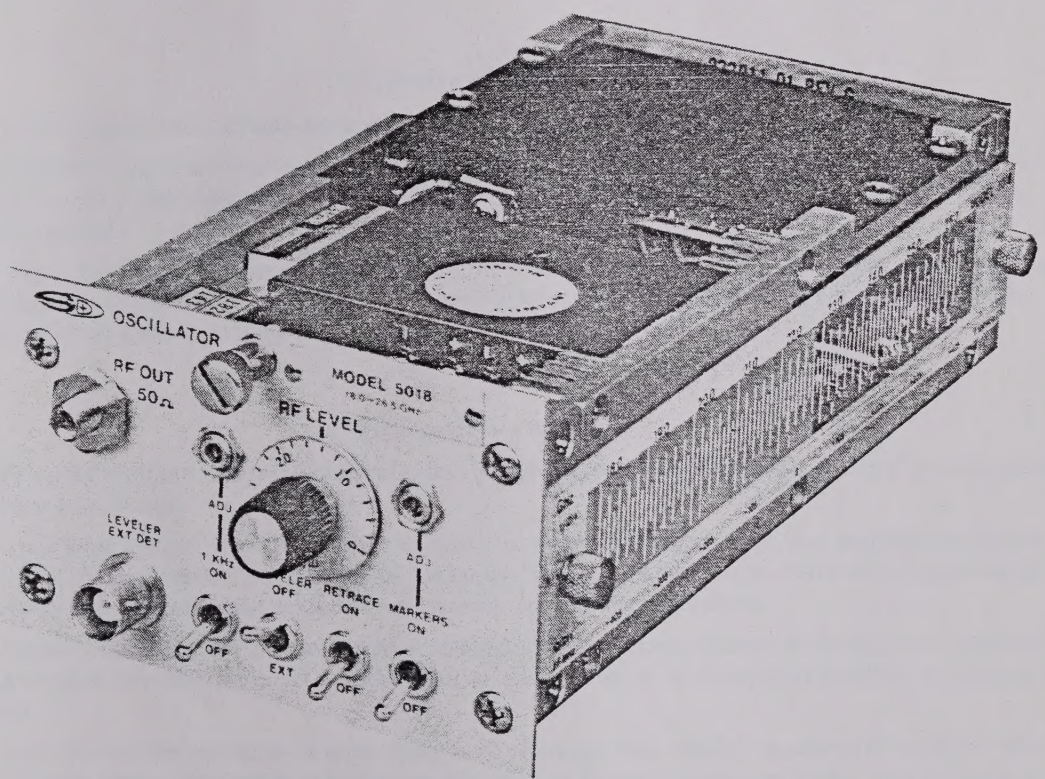
SYSTRON DONNER
Member THORN EMI Group

MODEL 5018
18 TO 26.5 GHz
RF PLUG-IN UNIT

INSTRUMENT DIVISION

OPERATING AND SERVICE MANUAL



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LIST OF EFFECTIVE PAGES

PAGE	CHANGE
Title	Original
i	Original
ii	Original
iii	Original
iv	Original
v	Original
vi	Original
vii	Original
viii	Original
1-1 through 1-6	Original
2-1 through 2-4	2-2-81
3-1 through 3-10	Original
4-1 through 4-48	Original
5-1 through 5-5	Original
5-6	Blank
5-7	Original
5-8	Blank
5-9	Original
5-10	Blank
5-11	Original
5-12	Blank
6-1 through 6-4	Original
7-1 through 7-7	Original
7-8	Blank
7-9	Original
7-10	Blank
8-1 through 8-3	2-2-81
8-4	Blank
8-5 through 8-9	2-2-81
8-10	Blank
8-11	2-2-81
8-12	Blank
8-13	2-2-81
8-14	Blank
8-15	2-2-81
8-16	Blank
8-17 through 8-19	2-2-81
8-20	Blank
9-1 through 9-3	2-2-81
9-4	Blank
9-5 through 9-7	2-2-81
9-8	Blank
9-9	2-2-81
9-10	Blank
9-11	2-2-81
9-12	Blank
9-13	2-2-81
9-14	Blank
9-15	2-2-81
9-16	Blank
9-17 through 9-19	2-2-81
9-20	Blank
9-21	2-2-81
9-22	Blank
9-23	2-2-81
9-24	Blank

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TABLE OF CONTENTS

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION I	GENERAL INFORMATION	1-1
1-1.	SCOPE	1-1
1-2.	DESCRIPTION OF EQUIPMENT	1-2
1-3.	CAPABILITIES AND PERFORMANCE	1-2
1-3.1	External Power Requirements	1-2
1-3.2	Frequency Range	1-2
1-3.3	Mainframes	1-2
1-3.4	Leveling and Amplitude Control	1-3
1-3.5	Frequency Modulation	1-3
1-3.6	Optional Configurations	1-3
1-3.6.1	Option M6 Wide-Deviation Phase Lock	1-3
1-3.6.2	Option M7 Power Meter Leveling	1-3
1-3.6.3	Option M7A Power Meter Leveling	1-3
1-4.	ACCESSORIES	1-3
1-4.1	Model 9001 Storage Cabinet	1-3
1-4.2	Model 9202 Plug-in Extender	1-3
1-4.3	Model 9203 Plug-in Inverter	1-4
1-4.4	Dial Drum	1-4
SECTION II	INSTALLATION	2-1
2-1.	UNPACKING AND INSPECTION	2-1
2-1.1	Removing Contents	2-1
2-1.2	Visual Inspection	2-1
2-1.3	Electrical Inspection	2-1
2-2.	PREPARATION FOR USE	2-1
2-2.1	Frequency Calibration Scales	2-1
2-2.2	Installation in 5000 or 5000A Sweeper	2-1
2-2-3	Installation in 540 or 540B Sweeper	2-3
2-3.	MAINFRAME MODIFICATION TO ACCEPT RF PLUG-IN	2-3
2-4.	REPACKAGING FOR SHIPMENT	2-4
2-5.	SHIPPING METHOD	2-4
2-6.	INSURANCE	2-4
2-7.	RETURNS FOR REPAIR	2-4
SECTION III	OPERATING INSTRUCTIONS	3-1
3-1.	SCOPE	3-1
3-2.	FRONT-PANEL CONTROLS AND CONNECTORS	3-1
3-3.	INITIAL OPERATING PROCEDURES	3-1
3-4.	HINTS AND PRECAUTIONS	3-1
3-4.1	Changing Plug-ins	3-1
3-4.2	External RF Components	3-1
3-4.3	Internal Square Wave Generator	3-4
3-4.4	External Amplitude Modulation	3-4
3-4.5	Leveling	3-4
3-4.6	Power Meter Leveling	3-5
3-4.7	Retrace	3-5
3-4.8	Markers	3-6
3-4.9	Phase Lock Input	3-6
3-4.10	Oscillator Current Limiting	3-7

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION IV	PERFORMANCE CHECKS AND CALIBRATION	4-1
4-1.	GENERAL	4-1
4-2.	PERFORMANCE CHECKS	4-1
4-2.1	Equipment Required	4-2
4-2.2	Alternate Test Equipment	4-2
4-2.2.1	Power Meter	4-2
42.2.2	Directional Detector	4-2
4-2.2.3	Crystal Detector	4-2
4-2.2.4	Connectors	4-2
4-2.3	Initial Setup	4-4
4-2.3.1	Description	4-4
4-2.3.2	Procedure	4-4
4-2.4	Frequency Accuracy	4-4
4-2.4.1	Description	4-4
4-2.4.2	Procedure	4-4
4-2.5	Power Output and External Leveling Flatness	4-6
4-2.5.1	Description	4-6
4-2.5.2	Procedure with External Leveler	4-6
4-2.5.3	Procedure without External Leveler	4-8
4-2.6	Unleveled Power Output and Flatness	4-9
4-2.6.1	Description	4-9
4-2.6.2	Procedure	4-9
4-2.7	Residual Amplitude Modulation	4-10
4-2.7.1	Description	4-10
4-2.7.2	Procedure	4-10
4-2.8	Oscillator Pulling and Attenuation	4-12
4-2.8.1	Description	4-12
4-2.8.2	Procedure	4-12
4-2.9	Residual Frequency Modulation	4-13
4-2.9.1	Description	4-13
4-2.9.2	Procedure	4-13
4-2.10	Spurious and Harmonic Content	4-14
4-2.10.1	Description	4-14
4-2.10.2	Procedure	4-14
4-2.11	Internal Amplitude Modulation	4-16
4-2.11.1	Description	4-16
4-2.11.2	Procedure	4-16
4-3.	CALIBRATION	4-18
4-3.1	General	4-18
4-3.2	Equipment Required for Calibration	4-18
4-3.3	Access to Calibration Components	4-21
4-3.3.1	Routine Frequency Calibration	4-21
4-3.3.2	Select-by-Test Calibration	4-21
4-3.4	Location of Components and Adjustments	4-26
4-3.5	Routine Frequency Calibration	4-26
4-3.5.1	5000A Mainframe	4-26
4-3.5.2	540 and 540B Mainframes/579 Adapter	4-26

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION IV	PERFORMANCE CHECKS AND CALIBRATION (Continued)	
4-3.6	General Procedure for Selection of Component Values	4-29
4-3.7	Oscillator Bias Voltage Setting	4-29
4-3.7.1	Description	4-39
4-3.7.2	Procedure	4-30
4-3.8	Frequency Range Resistor Selection	4-34
4-3.8.1	Initial Setup	4-35
4-3.8.2	Start and Stop Frequency Range Calibration	4-37
4-3.8.3	Tuning Current Limit Range Calibration in 5000A Mainframes	4-37
4-3.8.4	Tuning Current Limit Range Calibration in 540 and 540B Mainframes/579 Adapter	4-39
4-3.9	Leveling Loop Calibration	4-41
4-3.9.1	Amplitude Calibration	4-41
4-3.9.2	Leveling Loop Time Constant and Stability Calibration	4-44
4-3.10	1 kHz Square Wave Symmetry	4-47
SECTION V	MAINTENANCE	5-1
5-1.	GENERAL	5-1
5-2.	ROUTINE MAINTENANCE	5-1
5-3.	CALIBRATION	5-1
5-4.	CORRECTIVE MAINTENANCE	5-1
5-4.1	Trouble Isolation	5-1
5-4.1.1	Trouble Isolation Process	5-1
5-4.1.2	Supporting Information	5-2
5-4.1.3	Trouble Isolation Diagrams	5-2
5-4.2	Test Equipment	5-2
5-4.3	Printed Circuit Board Repair	5-3
5-4.4	Component Removal and Reassembly	5-3
5-4.5	Oscillator Module Repair and Replacement	5-4
5-5.	MODIFICATIONS AND OPTIONS	5-4
5-5.1	Option M6, Wide Deviation Phase Lock	5-4
5-5.2	Option M7, Negative Power Meter Leveling	5-5
5-5.3	Option M7A, Positive Power Meter Leveling	5-5
SECTION VI	THEORY OF OPERATION	6-1
6-1.	OVERALL FUNCTIONAL DESCRIPTION	6-1
6-1.1	Oscillator Driver	6-1
6-1.2	Amplitude Modulation Functions	6-1
6-2.	OSCILLATOR	6-1
6-3.	RF MODULATOR	6-3
6-4.	ISOLATORS	6-4

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION VII	CHASSIS ASSEMBLY	7-1
7-1.	REPLACEABLE PARTS LIST	7-1
7-1.1	Ordering Replacement Parts	7-1
7-1.2	Explanation of Table 7-3 Columns	7-1
7-1.2.1	Fig. No./Item No.	7-1
7-1.2.2	Ref. Desig.	7-1
7-1.2.3	Use Code	7-1
7-1.2.4	Systron-Donner Part Number	7-1
7-1.2.5	Mfr's Part Number.	7-1
7-1.2.6	Mfr. Code	7-1
7-1.2.7	Description	7-1
7-1.2.8	Qty.	7-2
7-1.3	Parts Breakdown	7-2
7-2.	SCHEMATIC DIAGRAMS	7-2
SECTION VIII	OSCILLATOR DRIVER	8-1
8-1.	GENERAL	8-1
8-2.	THEORY OF OPERATION	8-1
8-2.1	Operating Power	8-1
8-2.2	Overvoltage and Reverse Polarity Protection	8-2
8-2.3	Programming	8-2
8-2.3.1	Gunn Diode Oscillators	8-2
8-2.3.2	Transistor Oscillators.	8-2
8-2.4	Frequency Tuning	8-5
8-2.4.1	Tuning Current Amplifier	8-5
8-2.4.2	Tuning Current Limit	8-5
8-2.4.3	Quieting	8-5
8-2.4.4	FM Tuning Inputs	8-5
8-3.	TROUBLE ISOLATION	8-6
8-4.	REPLACEABLE PARTS LIST	8-6
8-4.1	Ordering Replacement Parts	8-6
8-4.2	Explanation of Columns	8-6
8-4.2.1	Fig No.	8-6
8-4.2.2	Ref. Desig.	8-6
8-4.2.3	Use Code	8-6
8-4.2.4	Systron-Donner Part Number	8-7
8-4.2.5	Mfr's Part Number.	8-7
8-4.2.6	Mfr. Code	8-7
8-4.2.7	Description	8-7
8-5.	SCHEMATIC DIAGRAMS	8-7
SECTION IX	LEVELER/AMPLITUDE MODULATOR	9-1
9-1.	GENERAL	9-1
9-2.	THEORY OF OPERATION	9-1
9-2.1	Drive Levels.	9-1
9-2.2	Operating Modes	9-1
9-2.2.1	Leveling Off Mode.	9-2
9-2.2.2	Fault Mode	9-2

TABLE OF CONTENTS (Continued)

SECTION/ PARAGRAPH	TITLE	PAGE
SECTION IX	LEVELER/AMPLITUDE MODULATOR (Continued)	
9-2.2.3	External Leveling Mode	9-2
9-2.2.4	Markers	9-5
9-2.2.5	Blanking	9-5
9-2.2.6	External AM	9-5
9-2.2.7	1 kHz Generator	9-5
9-2.2.8	Unleveled Indicator	9-5
9-2.2.9	Option M7	9-6
9-2.2.10	Option M7A	9-6
9-3.	TROUBLE ISOLATION	9-6
9-4.	REPLACEABLE PARTS LISTS	9-6
9-4.1	Ordering Replacement Parts	9-6
9-4.2	Explanation of Columns	9-6
9-4.2.1	Fig. No.	9-6
9-4.2.2	Ref. Desig.	9-6
9-4.2.3	Use Code	9-7
9-4.2.4	Systron-Donner Part Number	9-7
9-4.2.5	Mfr's Part Number	9-7
9-4.2.6	Mfr. Code	9-7
9-4.2.7	Description	9-7
9-5.	SCHEMATIC DIAGRAMS	9-7

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	Model 5018 RF Plug-in	1-1
2-1	Installation in Model 5000A Mainframe	2-2
2-2	Iinstallation in Model 540B with 579 Adapter	2-2
3-1	Model 5018 Front-Panel Controls and Indicators	3-2
3-2	Initial Operating Procedures	3-8
4-1	Test Setup for Frequency Accuracy Performance Checks	4-5
4-2	Test Setup for Output Power and External Leveling Flatness Performance Checks with External Directional Detector	4-7
4-3	Test Setup for Output Power and External Leveling Flatness Performance Checks without External Directional Detector	4-8
4-4	Test Setup for Unleveled Power Output and Flatness Performance Check	4-9
4-5	Test Setup for Residual Amplitude Modulation Performance Check	4-10
4-6	Typical Mixer Connection for Spurious Harmonic Content Performance Check	4-12
4-7	Typical Spectrum Analyzer Display of Residual FM	4-15
4-8	Test Setup for Internal Amplitude Modulation Performance Check	4-17
4-9	Demodulated Square Wave Characteristics	4-18
4-10	Service and Select-by-Test Calibration Configuration	4-22
4-11	Disassembly Sequence for Service and Select-by-Test Calibration	4-23
4-12	Location of Components, Adjustments, and Reference Test Points	4-24
4-13	Test Setup for Frequency Calibration in 5000A	4-26
4-14	Test Setup for Frequency Calibration in 540B/579	4-28
4-15	A1 Board Calibration Component Location	4-31
4-16	Test Setup for Oscillator Bias Voltage Setting	4-32
4-17	Test Setup for Frequency Range Calibration in Model 5000A Mainframe	4-35
4-18	Test Setup for Frequency Range Calibration in Model 540B Mainframe/ 579 Adapter	4-36
4-19	Test Setup for Tuning Current Limit Range Calibration in 5000A Mainframe	4-38
4-20	Test Setup for Tuning Current Limit Range Calibration in Model 540 or 540B Mainframe/579 Adapter	4-40
4-21	Test Setup for Leveling Loop Amplitude Calibration	4-42
4-22	A2 Board Calibration Component Location	4-43
4-23	Test Setup for Leveling Loop Stability Calibration	4-45
4-24	Test Setup for Leveling Loop Response Calibration	4-46
4-25	Demodulated Square Wave Characteristics	4-47
4-26	Test Setup for 1 kHz Symmetry Calibration	4-48
5-1	Troubleshooting Diagram	5-7
6-1	Model 5018 Block Diagram	6-2
6-2	Simplified Construction of YIG-tuned Gunn Diode Oscillator	6-3
7-1	Model 5018 RF Plug-in Illustrated Parts Breakdown	7-7
7-2	Model 5018 RF Plug-in Schematic/Wiring Diagram	7-9
8-1	Oscillator Driver Simplified Schematic Diagram	8-3
8-2	Oscillator Driver A1 Troubleshooting Diagram	8-9
8-3	Oscillator Driver A1 Parts Location/Schematic Diagram	8-19

LIST OF ILLUSTRATIONS (Continued)

FIGURE	TITLE	PAGE
9-1	Amplitude Modulator Simplified Schematic Diagram	9-3
9-2	Leveler/Amplitude Modulator A2 Troubleshooting Diagram	9-9
9-3	Leveler/Amplitude Modulator A2 Parts Location/Schematic Diagram	9-19
9-4	Power Meter Leveling Assembly A3 Parts Location/Schematic Diagram	9-23

LIST OF TABLES

TABLE	TITLE	PAGE
1-1	Performance Specifications	1-4
3-1	Model 5018 RF Plug-in Controls and Connectors	3-2
4-1	Performance Checks	4-1
4-2	Test Equipment Required for Performance Checks	4-3
4-3	Calibration Procedures	4-19
4-4	Test Equipment Required for Calibration	4-20
7-1	Model 5018 Chassis Assembly Use Codes	7-2
7-2	Manufacturers' Codes	7-3
7-3	Model 5018 RF Plug-in Chassis Parts List	7-4
8-1	Manufacturers' Codes	8-7
8-2	Oscillator Driver Assembly A1 Parts List	8-17
9-1	Manufacturers' Codes	9-7
9-2	Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List	9-7
9-3	Power Meter Leveling Assembly A3 (Option M7) Replaceable Parts List	9-21
9-4	Power Meter Leveling Assembly A3 (Option M7A) Replaceable Parts List	9-21

SECTION I

GENERAL INFORMATION

1-1. SCOPE

This manual provides general information, installation data, operating instructions, circuit descriptions, maintenance data, performance checks, calibration procedures, parts lists, and circuit diagrams for the Systron-Donner Model 5018 RF Plug-in.

The Model 5018 RF Plug-in Unit, hereinafter referred to as the Model 5018, the plug-in, or the unit, is shown in Figure 1-1 installed in a Model 5000A Sweeper Mainframe. Instructions for operation and service of the mainframe are contained within a separate manual.

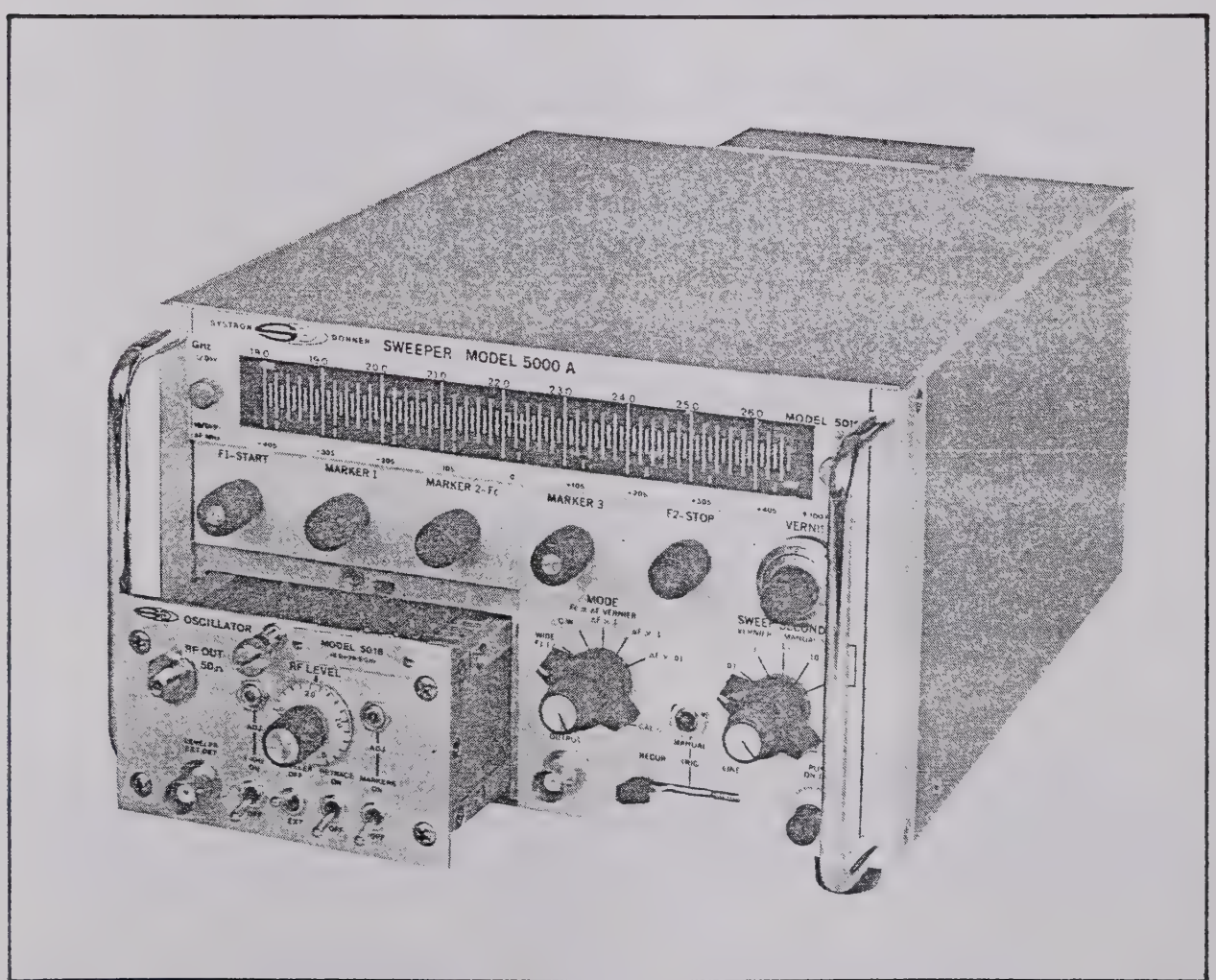


Figure 1-1. Model 5018 RF Plug-in

1-2. DESCRIPTION OF EQUIPMENT

The Model 5018 operates over the frequency range of 18 to 26.5 gigahertz; its output may be swept in either direction over all or any portion of this range, amplitude or frequency-modulated, or utilized as a frequency-agile RF source in systems operation.

The plug-in is supplied with a plastic dial scale calibrated for the 5018's usable frequency range of 18.0 to 26.5 gigahertz. This dial scale is installed in the Model 5000A mainframe at the time the 5018 is installed. Dial scales are available separately for use with other compatible mainframes.

Major subassemblies of the 5018 include an oscillator driver board, a leveler/amplitude modulator board, an optional power meter leveling board, a solid-state oscillator module, a PIN diode modulator, two microwave isolators, several chassis-mounted control switches and potentiometers, and a heatsink assembly containing oscillator bias and sweep voltage regulator transistors.

1-3. CAPABILITIES AND PERFORMANCE

The Model 5018 plug-in, used within an appropriate mainframe, is intended for use in laboratory and field tests of electronic communications components, subsystems, and systems by offering a precisely-calibrated alternative to time-consuming point-by-point testing of amplitude versus frequency characteristics over wide ranges.

Detailed performance specifications for the plug-in are given in Table 1-1.

Salient features of the unit are summarized in the following paragraphs.

1-3.1 External Power Requirements

All required power is supplied by the mainframe in which the 5018 is installed.

1-3.2 Frequency Range

The Model 5018 uses a fundamental-frequency YIG-tuned Gunn-diode oscillator to cover the 18 to 26.5 gigahertz range (radar band designation K, ECM band designation J/K). Operating and marker frequencies are indicated by colored pointers over the frequency scale of the mainframe. Dial accuracy is plus or minus one percent.

1-3.3 Mainframes

The 5018 RF Plug-in may be used in any plug-in sweeper mainframe currently manufactured by Systron-Donner and in many sweeper mainframes manufactured earlier with the *Kruse Electronics* (a division of Systron-Donner) nameplate. The 5018 is not compatible with the Model 5000 mainframe or with any mainframe which is not equipped with a cooling fan. Mainframes and adapters manufactured before 1981 may require physical modification to accept the 5018 RF plug-in. Refer to Section II of this manual. Compatibility of the 5018 plug-in with sweeper mainframes is delineated in Table 1-1.

Model 540 mainframes, unless equipped with Option M3 or M4, do not provide the outputs necessary to take advantage of the marker capability of the 5018. All Model 540B mainframes are equipped with marker outputs.

1-3.4 Leveling and Amplitude Control

Several methods of leveling (controlling the output amplitude of the plug-in to generate an essentially unvarying power level over the swept frequency range) and amplitude modulation are available. The output may be leveled by the feedback from an external negative-output crystal detector, or leveled by the output of a microwave power meter (Options M7 and M7A). The 5018 may also be operated in an unleveled mode to obtain maximum peak power over narrow frequency ranges. The output may be modulated by a one kilohertz square wave generated within the 5018, or modulated by an externally-supplied input generated by or fed through the mainframe.

1-3.5 Frequency Modulation

In addition to the frequency-control signals from the mainframe, a wideband phase-lock input signal may be coupled through the mainframe directly to an auxiliary tuning coil in the RF oscillator module of the 5018. Deviations of up to plus or minus 125 megahertz from the nominal output frequency, at a bandwidth of up to one megahertz, are possible through the phase lock connection.

1-3.6 Optional Configurations

1-3.6.1 OPTION M6 WIDE-DEVIATION PHASE LOCK. This option modifies the 5018 to accept external phase-lock inputs into the main frequency tuning circuits rather than into the auxiliary tuning coil of the oscillator module. The output of the 5018M6 may be deviated over a wide frequency range, but with restricted bandwidth. A voltage drive is used to frequency-modulate the output rather than the current drive (up to 1 Ampere) required by the auxiliary tuning coil in unmodified 5018's. Option M6 is available concurrently with Option M7 or M7A.

1-3.6.2 OPTION M7 POWER METER LEVELING. Model 5018 RF plug-ins equipped with Option M7 are characterized by an additional front-panel toggle switch marked POWER METER/NORMAL and an additional circuit board mounted within the plug-in. The optional circuitry allows the output amplitude of the plug-in to be controlled by the analog output of any RF power meter which is of negative polarity and has a full-scale amplitude of one volt.

1-3.6.3 OPTION M7A POWER METER LEVELING. Option M7A allows the 5018 to accept a positive-polarity power meter output as an amplitude-control (leveling) input. The zero to plus one volt "recorder" output of Hewlett-Packard 435 and 436-series RF power meters is typical of acceptable inputs for the 5018M7A.

1-4. ACCESSORIES

1-4.1 Model 9001 Storage Cabinet

The storage cabinet holds four 5000-series RF plug-ins with their dial scales, and bolts on to the side of a 5000A mainframe to form a unit in 5¼ inches of rack space. The storage cabinet keeps the plug-ins available, and prevents loss of dial scales or damage to plug-ins. Storage cabinets manufactured before 1981 may require physical modification to accept a 5018 plug-in; refer to Section II.

1-4.2 Model 9202 Plug-in Extender

This unit fits between the sweeper mainframe and the 5018 RF plug-in to allow access to internal circuitry for trouble isolation and repair.

1-4.3 Model 9203 Plug-in Inverter

Used in conjunction with the 9202 extender, this maintenance accessory allows physical inversion of the 5018 for easier testing or trouble isolation of the oscillator driver circuit board.

1-4.4 Dial Drum

When the 5018 is used with a Model 579 Adapter in a Model 540 or 540B mainframe, the plastic dial scale supplied with the RF plug-in must be replaced by a properly calibrated dial drum installed in the mainframe. A metal dial scale, available on special order, replaces one of the four dial scales on any standard 540 dial drum to cover the 18 to 26.5 gigahertz band. 540-series mainframes are no longer in production; the 579 adapter dial drum may become unavailable in the future.

Table 1-1. Performance Specifications

ITEM	PARAMETER	SPECIFICATION
1	Mainframe Compatibility	
1.1	Model 5000A	Modified as noted in Section II of this manual
1.2	Model 540*	All, using Model 579* Adapter (modified per Section II)
1.3	Model 540B*	All, using Model 579* Adapter (modified per Section II)
2	Frequency Range	18.0 to 26.5 GHz
3	Frequency Accuracy	$\leqslant \pm 85$ MHz @ 25° ambient and full power output
4	Frequency Stability	CW mode
4.1	Δ Temperature from +10 to +60°C (+50 to +140°F)	$\leqslant \pm 150$ MHz
4.2	Load VSWR from 1:1 to 3:1, any phase	$\leqslant \pm 0.1\%$ of F_o
4.3	Δ RF Power, min to max	$\leqslant \pm 0.1\%$ of F_o
4.4	Δ Line Voltage of ±10%	$\leqslant \pm 0.001\%$ of F_o (worst-case combination of mainframe and Model 5018 specifications)
5	Unleveled RF Power Output	$\geqslant$ 1.0 mW (0 dBm) into 50 Ω load
6	Power Control Range	
6.1	Unleveled	$\geqslant$ 30 dB
6.2	Externally Leveled	$\geqslant$ 6 dB
7	Source VSWR (Leveled Mode)	$\leqslant$ 2.1:1 at any output amplitude

**Units not in current production*

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION
8	Power Variation (Flatness)	
8.1	Unleveled, Full Band	⩽ ±6 dB
8.2	Unleveled, Fine Grain	⩽ ±1.5 dB/100 MHz
8.3	Externally Leveled	⩽ ±0.05 dB (excluding variations in external leveling apparatus)
9	Spurious Signals	Amplitude below full rated output, ⩾ 1 MHz from output frequency
9.1	Harmonically-related	⩾ 30 dB
9.2	Non-Harmonic	⩾ 60 dB
10	Residual FM Deviation, CW Mode	40 kHz peak, 1 Hz to 30 kHz bandwidth
11	Residual AM Index	@ Full power output, 100 kHz bandwidth
11.1	Unleveled	⩾ -46 dB
11.2	Externally Leveled	⩾ –40 dB
12	Vernier Range	100 MHz maximum
13	ΔF Range	±425 MHz maximum
14	External Phase Lock	
14.1	Model 5018	Normally-supplied configuration
14.1.1	Sensitivity	≈ 125 kHz/mA
14.1.2	Maximum Deviation	±125 MHz
14.1.3	3 dB Bandwidth	1 MHz typical
14.1.4	Maximum Deviation/Rate	100 MHz @ 500 kHz
14.1.5	Coil Resistance	⩽ 1 Ω
14.1.6	Maximum Current	1.0 A
14.1.7	Maximum Voltage	1.0 V
14.2	Model 5018M6	With wide-deviation phase-lock option
14.2.1	Sensitivity	≈ 85 MHz/V
14.2.2	3 dB Bandwidth	10 kHz
14.2.3	Impedance	1 MΩ
14.2.4	Maximum Voltage	±100 V
15	External Leveling	
15.1	Model 5018	Normally-supplied configuration
15.1.1	Sensitivity	–10 mV/mW
15.1.2	Impedance	5 kΩ nominal

Table 1-1. Performance Specifications (Continued)

ITEM	PARAMETER	SPECIFICATION
15	External Leveling (Cont.)	
15.2	Model 5018M7	With negative power meter leveling option
15.2.1	Sensitivity	–1 V/mW @ 1 mW full scale
15.2.2	Maximum Input	–10 V
15.2.3	Impedance	5 kΩ nominal
15.3	Model 5018M7A	With positive power meter leveling option
15.3.1	Sensitivity	+1 V/mW @ 1 mW full scale
15.3.2	Maximum Input	+10 V
15.3.3	Impedance	⩾ 10 kΩ
16	Markers	
16.1	Minimum Marker Amplitude	⩽ 0.2 dB in leveled output mode
16.2	Maximum Marker Amplitude	⩾ 2 dB in leveled output mode
16.3	Marker Polarity	Reduces RF output amplitude
17	Internal Amplitude Modulation	
17.1	Waveform	Square wave
17.2	Frequency	1000 Hz
17.3	Stability	⩽ ±1 Hz
17.4	Adjustment Range	⩾ ±50 Hz
17.5	Symmetry	⩽ 5%
17.6	Risetime	⩽ 10 μs at maximum leveled output
17.7	Falltime	⩽ 10 μs at maximum leveled output
17.8	On/Off Ratio	⩾ 30 dB
18	External Amplitude Modulation	
18.1	Sensitivity	+100 mV/mW in leveled mode
18.2	Maximum Input	+10 V peak
18.3	Impedance	⩾ 10 kΩ
18.4	3 dB Bandwidth	30 kHz nominal
19	Environment	
19.1	Operating Temperature	+10 to +60°C (+50 to +140°F)
19.2	Storage Temperature	–20 to +71°C (–4 to +160°F)
19.3	Altitude	0 to 10,000 feet (3,05 kilometers)
20	Dimensions	
20.1	Height	2.40 inches (6,1 centimeters)
20.2	Width	3.87 inches (9,83 centimeters)
20.3	Depth	9.625 inches (24,5 centimeters)
21	Weight	≈ 5 pounds (2,3 kilograms)

SECTION II

INSTALLATION

2-1. UNPACKING AND INSPECTION

The RF plug-in is shipped in a specially-constructed container to provide maximum protection during transit. Use care when unpacking to prevent damage to the equipment, such as the front panel finish, switches, connectors, etc.

2-1.1 Removing Contents

To remove the plug-in from the shipping container, cut and fold back the outer carton top flaps, remove the top protective cushion, lift the plug-in clear from shipping container, and remove it from the dust protection bag.

2-1.2 Visual Inspection

The plug-in was carefully tested and inspected prior to shipment. Carefully inspect it for damage incurred during shipment. If the plug-in is damaged in any way, notify the freight carrier immediately. Do not discard any packing materials, as the freight carrier's agent will wish to examine them.

2-1.3 Electrical Inspection

Conformance with operation and performance specifications may be verified by following the *performance check* procedures in Section IV of this manual.

2-2. PREPARATION FOR USE

2-2.1 Frequency Calibration Scales

Depending upon the type of sweeper with which the RF plug-in is to be used, a clear plastic dial scale (5000 and 5000A) or a metal dial drum (540/579 or 540B/579) is required. The clear plastic dial scale is shipped with the plug-in at no charge.

2-2.2 Installation in 5000 or 5000A Sweeper (Figure 2-1)

To install a plug-in in one of these units:

1. Remove the clear plastic dial scale from the bracket on the right side of the plug-in by loosening the two captive knurled knobs.

2. Insert the RF plug-in through the rectangular hole in the sweeper front panel.

CAUTION

DO NOT FORCE THE RF PLUG-IN IF IT DOES NOT SLIDE IN EASILY. THE PLUG-IN OR MAINFRAME MAY BE DAMAGED IF FORCE IS USED. REFER TO PARAGRAPH 2-3 IN CASE OF DIFFICULTY.

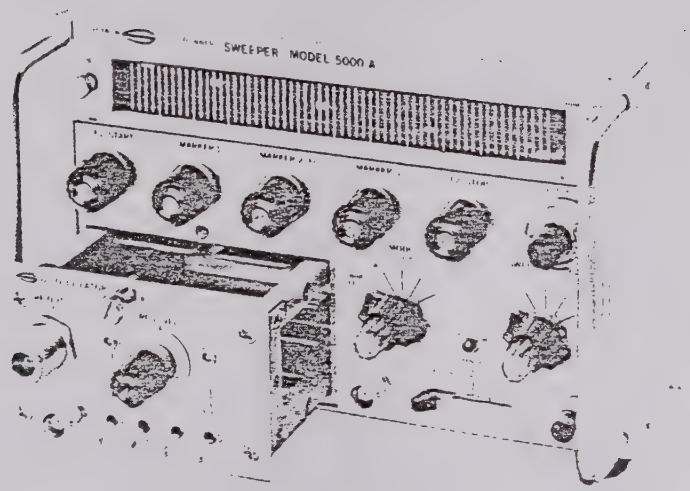


Figure 2-1. Installation in Model 5000A Mainframe

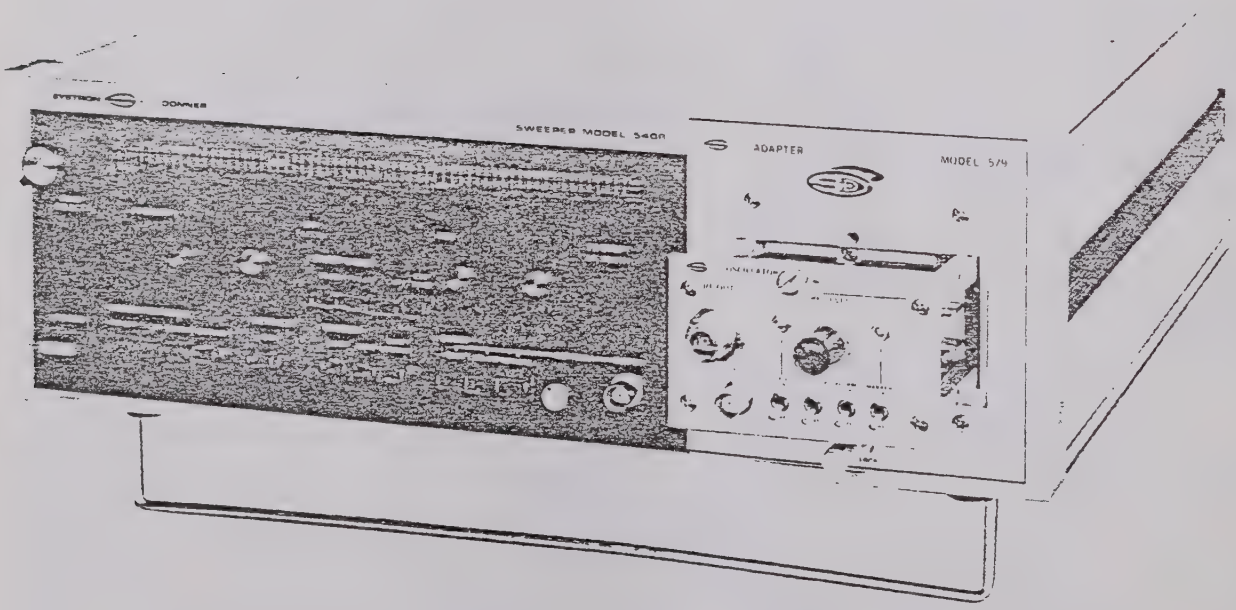


Figure 2-2. Installation in Model 540B with 579 Adapter

3. Lock the plug-in in place by turning the small knob at the top of the plug-in clockwise.

4. Install the clear plastic dial plate in the large rectangular cutout at the top of the sweeper.

5. Simultaneously tighten both knurled screws by turning them clockwise until they are finger tight. Be sure the dial fits in the panel without binding.

2-2.3 Installation in 540 or 540B Sweeper (Figure 2-2)

A single 5000-series RF plug-in may be installed in a Model 540 or 540B sweeper if it has been fitted with a Model 579 adapter. (These units are not in current production.)

1. Remove the clear plastic dial scale from the bracket on the right side of the plug-in by loosening the two captive knurled knobs. The dial scale is not used in this application.

2. Insert the RF plug-in into the rectangular hole in the center of the 579 adapter.

CAUTION

DO NOT FORCE THE RF PLUG-IN IF IT DOES NOT SLIDE IN EASILY. THE PLUG-IN OR MAINFRAME MAY BE DAMAGED IF FORCE IS USED. REFER TO PARAGRAPH 2-3 IN CASE OF DIFFICULTY.

3. Lock the plug-in in place by turning the small knob at the top of the plug-in clockwise.

4. Set the 1 KHZ switch of the RF plug-in to OFF.

5. Set the RETRACE switch of the RF plug-in to ON.

6. Connect a BNC cable between the MARKER INPUT connector on the rear panel of the 579 adapter and the AMPLITUDE MARKER OUTPUT connector on the rear panel of the 540B, 540M3, or 540M4 mainframe.

7. If necessary, install a new dial drum in the mainframe following steps *8* through *13*.

8. Remove the top cover of the mainframe; it is held in place with two screws.

9. Face the instrument, holding the dial scale drum with its smooth, rounded end knob to the right.

10. Push the smooth knob into its mating receptacle near the plug-in compartment shield. The spring will give way, allowing you to lower the left side of the drum.

11. Snap the drum into place and align the locating key with the mating groove in the left side of the drum assembly.

12. Rotate the BAND SELECT knob to ensure smooth operation of the drum assembly.

13. Set the BAND SELECT knob so that the dial scale matching the range of the RF plug-in is displayed.

14. Replace the top cover using the shorter screw on the right side.

2-3. MAINFRAME MODIFICATION TO ACCEPT RF PLUG-INS

Sweeper mainframes manufactured prior to January 1979 may require physical modification to accept some RF plug-in models manufactured after this date. The affected RF plug-in models include:

1. Model 5015 (8 to 12.4 GHz)
2. Model 5015-2 (7 to 11 GHz)
3. Model 5015-5 (10.7 to 11.7 GHz)
4. Model 5016 (12.4 to 18 GHz)
5. Model 5016-2 (10 to 15 GHz)
6. Model 5018 (18 to 26.5 GHz)
7. Model 5030 (1 to 4 GHz)
8. Model 5031 (8 to 18 GHz)

Modification instructions and required parts will be supplied upon request. Please supply the model number(s) and serial number(s) of the sweeper mainframes for which modification kits are required.

2-4. REPACKAGING FOR SHIPMENT

If the plug-in is to be packaged for re-shipment, use the original shipping container and packaging material. If the original packaging has been discarded or is not in condition for re-use, perform the following packaging procedure. The plug-in may be shipped while it is housed within a mainframe:

1. Wrap the instrument in a heavy paper wrapping or plastic protective covering.
2. Place protective cushion in the bottom of shipping carton and place the instrument on the cushion.
3. Surround the remaining sides and top with additional protective cushions. Place front and rear cushions to provide support of the instrument without resting on the controls or connectors.

2-5. SHIPPING METHOD

This instrument should be shipped only by truck freight, air freight, or parcel delivery service. If it is shipped by parcel post, damage is likely to occur. Systron-Donner is not responsible for units damaged in shipment to the factory for repair, whether such units are in warranty or not.

2-6. INSURANCE

For your own protection, insure the unit for full value whenever it is shipped.

2-7. RETURNS FOR REPAIR

Be sure to fully identify any instrument that is returned to Systron-Donner for repair of any kind, in-warranty or not. The paperwork with the unit must show the instrument serial number, a description of the problem or malfunction to be corrected, and the exact address to which the instrument should be returned when repair is completed. Please also include the *name* and *telephone number* of the cognizant party in your organization: this may speed the identification and repair of malfunctions.

SECTION III

OPERATING INSTRUCTIONS

3-1. SCOPE

This section contains descriptions of all operating controls and indicators, an initial operating procedure, and a summary of precautions for proper usage of the 5018 RF plug-in. Specific operating instructions for the sweeper mainframe are contained in the manual supplied with the sweeper.

3-2. FRONT-PANEL CONTROLS AND CONNECTORS

The front-panel controls and connectors are illustrated in Figure 3-1, and are listed and described in Table 3-1.

3-3. INITIAL OPERATING PROCEDURES

Figure 3-2 contains condensed initial operating procedures for the 5018 and 5000A mainframe. These procedures are applicable to any swept signal measurement situation over the operating range of the plug-in, and generally apply to any mainframe in which the 5018 may be used.

3-4. HINTS AND PRECAUTIONS

3-4.1 Changing Plug-ins

It is imperative that the mainframe power be turned off before removing or inserting the 5018 RF plug-in. Serious damage to the 5018 or mainframe could result if this caution is ignored.

3-4.2 External RF Components

The RF output connector of the 5018 is a precision 3.5-millimeter (APC-3.5) female rated for mode-free operation to 34 gigahertz. This connector will mate with any standard SMA (MIL-C-39012) plug. However, SMA connectors are not specified for operation in the 18 to 26.5 gigahertz band; most SMA connectors have modes above 22 gigahertz. Any cables, attenuators, or other RF components used with the 5018 should have APC-3.5 or improved SMA connectors with specified performance to at least 26.5 gigahertz.

CAUTION

EXERCISE CARE CONNECTING EXTERNAL COMPONENTS TO THE 5018 RF OUTPUT CONNECTOR. THE APC-3.5 FEMALE USES BEAD SUPPORTS RATHER THAN SOLID DIELECTRIC. IT IS MORE DELICATE THAN A STANDARD SMA CONNECTOR, AND MAY BE DAMAGED BY MISALIGNMENT OR OVERTIGHTENING OF THE MATING DEVICE'S RF PLUG.

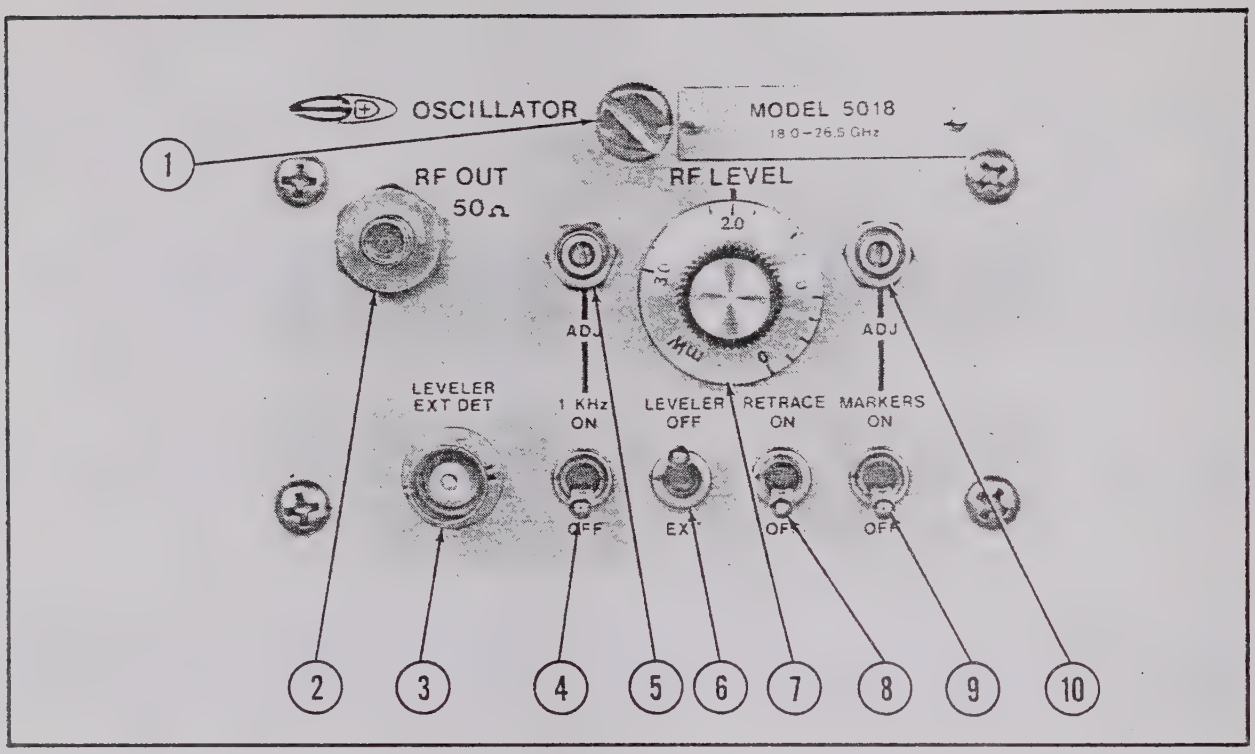


Figure 3-1. Model 5018 Front-Panel Controls and Connectors

Table 3-1. Model 5018 RF Plug-in Controls and Connectors

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
1	Locking Screw	Used to lock plug-in in place in mainframe. *NOTE: This knob must be tightened to ensure low noise and proper seating of the interface connector.*
2	RF OUT 50Ω connector	The RF output of the plug-in is coupled through the precision APC-3.5 connector. The output impedance at this port is 50 Ω.
3	LEVELER EXT DET connector	Accepts video output of external directional detector for precision power leveling at the load. Sensitivity is approximately 10 mV/mW of output power. Input impedance is 5 kΩ, negative polarity. For Model 5018M7, a zero to –1 V power meter "recorder" output signal may be used instead of the output of a crystal detector.

Table 3-1. Model 5018 RF Plug-in Controls and Connectors (Continued)

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
4	**1 KHZ** switch	When set to **ON**, 100% amplitude-modulates the RF output of the 5018 with a 1 kHz square wave.
5	**1 KHZ ADJ** control	Controls the frequency of the internal 1 kHz square wave generator from ≈ 950 to 1050 Hz.
6	**LEVELER** switch	When set to **OFF**, the RF output is unleveled; the **RF LEVEL** control is used to adjust the output amplitude of the 5018. Maximum peak power output is available in this position. This position is used for external power meter leveling with Model 5018M7. At the **EXT** setting, the 5018 is externally leveled using an appropriate directional detector. In this position, an external negative voltage at the **LEVELER EXT DET** connector is used to control the RF output over the 18 to 26.5 GHz frequency range. Model 5018M7 may be leveled with the 0 to −1 V output of a power meter through this port.
7	**RF LEVEL** control	Setting determines the RF output amplitude of the 5018. This control typically has a range of over 30 dB in unleveled and at least 6 dB in leveled mode. The "1" dial calibration marking may be read as 1 milliwatt when a matched −10 mV/mW external leveler is used. (The 5018 has a specified maximum output of 1 milliwatt, but will typically generate higher output amplitudes. In that case, the "2" and/or "3" markings may be read as milliwatts.) The dial is not calibrated in unleveled mode.
8	**RETRACE** switch	When set to **ON**, RF output is left on during the time the sweep circuits are retracing. When the switch is set to **OFF**, the internal modulator is automatically set to maximum attenuation during sweep retrace.
9	**MARKERS** switch	When set to **ON**, turns on RF dip markers as set by mainframe controls. The switch is set to **OFF** when the 5018 is used in any sweeper mainframe other than the 5000A.

Table 3-1. Model 5018 RF Plug-in Controls and Connectors (Continued)

INDEX NO. (FIG. 3-1)	FRONT PANEL NAME AND DESCRIPTION	FUNCTION
10	MARKERS ADJ control	Setting determines amount of RF signal attenuation at marker points and thus the size of the markers. Range of this control when the 5018 is operating in leveled mode is ≈ 0.2 to 2.0 dB.
Not Shown	POWER METER switch	Present in Models 5018M7 and 5018M7A; this switch is set to NORMAL in order to level the RF output with an external directional detector. The 0 to –1 V (Option M7) or 0 to +1 V (Option M7A) output of an RF power meter is used for leveling when the switch is set to POWER METER.

3-4.3 Internal Square Wave Generator

The internal one kilohertz generator drives the modulator with a square wave, reducing the RF output of the 5018 to minimum on positive peaks. Most VSWR amplifiers and ratiometers will respond to the demodulated one kilohertz signal. If one of these units is being used, the 1 KHZ ADJ control should be tuned for maximum response of the meter in use before measurements are made. Tuning the plug-in modulating frequency to that of the VSWR amplifier will considerably increase the measurement accuracy and signal-to-noise ratio.

If the 5018 is used in a 540-series mainframe with 579 adapter, the 1 KHZ switch should be set to OFF; these mainframes have internal one kilohertz generators. The MODULATION MODE 1 KHZ switch of the 540 or 540B should be used to control the one kilohertz modulating signal. The frequency of the square wave may be adjusted with a mainframe rear-panel adjustment.

3-4.4 External Amplitude Modulation

Each mainframe in which the 5018 may be used has a rear-panel connector through which external amplitude modulation signals may be coupled to the leveler/amplitude modulation circuits, where they are summed with all other amplitude modulation signals (internal one kilohertz, RF LEVEL control setting, retrace blanking, and markers).

This external input is dc-coupled, at an approximate sensitivity of minus 100 millivolts per milliwatt of RF output. A negative-polarity input will decrease the output amplitude of the 5018; positive inputs will increase the amplitude. An input level of minus seven volts is sufficient to overcome the effects of all other amplitude-control signals, functioning as a remote "RF off" signal.

3-4.5 Leveling

Leveling is the process which overcomes the natural tendency of radio frequency sources to generate different power levels at different frequencies due to resonances, losses, and other frequency-sensitive factors. The desired end result is identical output power over the full 18 to 26.5 gigahertz range of the 5018. To be most useful, leveling should be accomplished as closely as possible to the point of measurement. When external leveling is used, the power level at the output of the leveler is essentially identical for all output frequencies.

The front-panel LEVELER EXT DET connector accepts the input from a directional detector at an approximate sensitivity of minus ten millivolts per milliwatt. The actual power level at the output connector of the directional detector may be measured with a microwave power meter and correlated with dial markings on the RF LEVEL control as reference points.

Specified output power of the 5018 is 1 millwatt (0 dBm), but most 5018's are capable of generating RF power in excess of the specified limit. If the 5018 has been correctly calibrated and is used with a matching leveling detector, the 1 marking will correspond to 1 milliwatt, the 2 to 2 milliwatts, and so forth. When the leveled RF output is detected and displayed on an oscilloscope, the RF amplitude at which excessive ripple begins to appear on the displayed trace is the unleveled point.

An effective directional detector can be assembled from a six decibel directional coupler which is flat over the 18 to 26.5 gigahertz band and a microwave crystal detector with matching square-law load. A power divider may be used in lieu of the directional coupler.

If the 5018 is equipped with power meter leveling Option M7 or M7A, the POWER METER/NORMAL switch must be set to NORMAL when a crystal detector is used as the leveling element. Response time of the leveling circuitry is slowed considerably in a power meter leveling mode.

NOTE

If the LEVELER switch is set to EXT, and an external leveler is not connected, it will not be possible to control the output amplitude with the RF LEVEL control. The RF output will either be completely off or at maximum amplitude.

3-4.6 Power Meter Leveling

Model 5018M7 RF plug-ins will accept an external leveling input from a negative-output crystal detector as described in Paragraph 3-4.5 above, or may be leveled with the analog "recorder" output of any power meter which has a negative one-volt level corresponding to full scale. The LEVELER switch must be set to EXT and the POWER METER/NORMAL switch to POWER METER; the input is connected to the LEVELER EXT DET connector.

Model 5018M7A is similar, but accepts the positive one-volt output of a power meter such as Hewlett-Packard 435 and 436, and units from other manufacturers. To use positive power meter leveling, the front-panel POWER METER/NORMAL switch must be set to NORMAL, the LEVELER switch to OFF, and the power meter output connected to the rear-panel *external A.M.* jack of the mainframe.

Both modes of power meter leveling are suitable for use only at the slower sweep speeds. The detection elements used in most power meters have relatively slow response to amplitude changes and will not properly level the 5018 when the mainframe is operating in a fast sweep mode. The response time of the 5018 leveling circuitry is also reduced in power meter leveling mode, and will not accept fast amplitude changes.

3-4.7 Retrace

When the front-panel RETRACE switch is set to OFF, the internal modulator of the 5018 is automatically driven to maximum attenuation during the time the sweep ramp from the mainframe is retracing. This eliminates a possibly confusing extra trace from the oscilloscope or display unit screen. However, under certain circumstances, the RETRACE switch should be set to ON where it is desired that the RF output of the 5018 remain on at all times, such as when average power is being measured,

when certain chart recorders are being used, and when phase-locked systems are in use. The fast-rising pulses at both ends of sweep might cause measurement errors.

If an RF power meter is being used to measure output power of the plug-in at high sweep speeds, it will indicate average power over the swept band, provided the sweep retrace is not blanked. Setting the RETRACE switch to OFF will blank the RF output during sweep retrace and cause the power meter to indicate a lower power amplitude than is actually present. The fast-rising and falling voltages of the beginning and end of sweep retrace will also cause disturbances when logarithmic converters or crystal-detector type logarithmic power meters are used, causing abnormal power levels to be indicated at fast sweep speeds.

If the 5018 is used in a 540 or 540B mainframe with a 579 adapter, the plug-in's RETRACE switch should be left at ON, and the RETRACE switch on the mainframe or controller used to select the retrace mode.

3-4.8 Markers

Markers are generated in the 5018 plug-in by momentarily reducing the RF output power in response to marker signals from the mainframe (Model 540 mainframes must be equipped with Option M3 or M4).

The size of the markers is controlled by the front-panel MARKERS ADJ potentiometer; the minimum size is equivalent to a power reduction of about 0.2 decibel. Under certain circumstances, RF dip markers may not be usable; where there is a great deal of attenuation in the system under test, or when the 5018 is generating maximum unleveled power, the markers may not be visible on the detected waveform. In these cases, the other methods of marker generation (video bypass, intensity, sweep stop) described in the mainframe manual should be used. Very high "Q" circuits may cause oscillations (ringing) at marker points due to the fast rise and fall times of the marker pulses. In these cases, too, an alternate method of marker generation *not* involving output amplitude reduction should be employed.

3-4.9 Phase Lock Input

The phase lock input for the 5018 RF plug-in is physically located on the rear panel of the mainframe or adapter, but electrically connects directly to the oscillator module in the plug-in. Generally, the phase lock input is used to directly control the oscillator frequency to maintain a fixed output frequency or to generate FM. In the first case, the output of a discriminator is commonly used; in the second case, the ac-coupled output of a low-frequency oscillator is used.

Considerable current is required to drive the FM coil in the oscillator; up to one Ampere is needed to deviate the output frequency to its rated maximum of 125 megahertz. If wider deviation is required, Model 5018M6 with the optional *wide phase-lock* connection should be used. Modification instructions for converting the 5018 to *wide phase-lock* operation can be found in Section V of this manual.

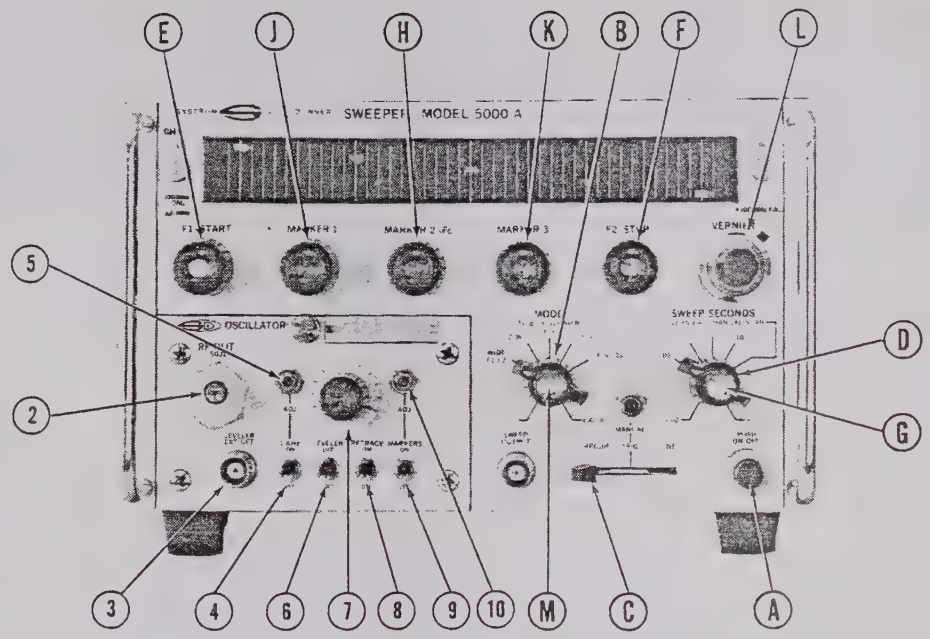
Response of the standard phase lock input is linear with current at a sensitivity of approximately 125 kilohertz per milliampere. Frequency response is approximately one megahertz (half-power points). When the *wide phase-lock* option is used, the amplitude response is linear at about 85 megahertz per volt with a frequency response of about ten kilohertz. The polarity of the phase lock input determines the direction of frequency deviation: positive inputs increase the output frequency and negative inputs decrease it.

To ensure low residual FM in the RF output, it is important that the phase lock input be short-circuited when it is not in use. The PHASE LOCK jack on the mainframe or adapter is self-shorting when the mating plug is removed. An unterminated lead connected to the PHASE LOCK jack will act as an antenna, coupling electromagnetic and electrostatic noise into the frequency-control circuits of the 5018.

3-4.10 Oscillator Current Limiting

When an excessive external tuning or phase-lock input is coupled through the mainframe, the frequency of the 5018 may be driven outside the 18.0 to 26.5 gigahertz band; the main tuning coil in the oscillator module could be driven beyond its rated current limit. To prevent unstable or non-linear operation, a tuning current limiting circuit is interposed between the drive current source and the tuning coil. When tuning current limiting has occurred, the RF output of the 5018 will be held at about 26.6 gigahertz, and further increases in tuning voltage will not cause an increase of output frequency. The RF output power of the 5018 may drop to a low level when the frequency is tuned out of the rated band in this manner. To reset the current limiting circuits, simply tune the frequency below the rated maximum.

If the output amplitude does not increase to a normal level after the frequency has been retuned, turn off the mainframe power for at least 15 seconds before turning it back on.



A. PRELIMINARY CONTROL SETTINGS IN 5000A

Control	Setting
RF LEVEL (7)	Maximum CCW
PUSH ON-OFF (A)	Depressed to turn mainframe power on
RF OUT 50 Ω (2)	Connect suitable RF output cable to circuit or device to be sweep tested
1 KHZ (4)	OFF
MODE (B)	WIDE F1–F2
RETRACE (8)	OFF
MARKERS (9)	OFF
TRIGGER (C)	RECUR
SWEEP SECONDS (D)	.1
SWEEP SECONDS VERNIER (G)	x1

B. TYPICAL TEST METHOD IN 5000A

Control	Setting
F1–START (E)	Adjust so *GOLD* dial indicator is at lowest frequency of interest

Figure 3-2. Initial Operating Procedures (Sheet 1 of 3)

F2–STOP (F)	Adjust so *ORANGE* dial indicator is at highest frequency of interest
LEVELER (6)	OFF
RF LEVEL (7)	Slowly increase the RF output of the plug-in while observing detected response of test item on display unit (oscilloscope or chart recorder).

Continue to increase the RF amplitude until the desired power level is reached. If an external leveler is used, connect its input to LEVELER EXT DET (3) and set the LEVELER switch (6) to EXT. Increase power until the output becomes unleveled as indicated on the display unit trace. Reduce setting of RF LEVEL control (7) as required.

If the shape of the swept response changes as a function of SWEEP SECONDS VERNIER (G) setting, reduce sweep speed until the distortion is no longer evident. This effect may be noticed when sweeping high-Q circuits, when the crystal detector output capacitor is of high value, or when logarithmic converters are used at the display unit input. In general, use the lowest sweep speed which allows comfortable viewing of the display unit trace with minimal distortion.

To use direct reading frequency markers, set MARKERS switch (9) to ON.

Adjust MARKER 2 (H) until the pip on the trace is over an area of interest in the swept response curve. The frequency of the discontinuity, anomaly, or other event is shown by the *RED* dial indicator. Adjust MARKER 1 (J) and MARKER 3 (K) to calibrate the swept response curve at points on either side of the frequency of interest. In many cases, it will be desirable to examine parts of the trace using narrow sweeps without disturbing the F1—F2 settings:

Control	Setting
MARKER 2–Fc (H)	Adjust so marker 2 is centered in the narrow band area of interest
MODE (B)	Fc ± ΔF x 1
MARKER 1 (J)	Set marker 1 so *GREEN* indicator shows lower calibration frequency on lower part of frequency scale
MARKER 3 (K)	Set marker 3 so *BLUE* indicator shows upper calibration frequency on lower part of frequency scale
Fc ± ΔF VERNIER (M)	Set to CALIB. When ΔF sweep width is reduced by rotating control CCW, Markers 1 and 3 become uncalibrated.

Figure 3-2. Initial Operating Procedures (Sheet 2 of 3)

C. OTHER CONTROLS

1. TRIGGER (C) : Trigger modes other than recurrent have specific uses. In line trigger mode, the effects of power ground loops or power line-frequency noise in the displayed swept response curve can be minimized by synchronizing the sweep with these components. Manual mode is used for single sweeps or sweeps triggered on command when chart recorders or other plotting devices are used.

2. RETRACE (8) : If a fast-rising pulse caused by turning off the RF output of the plug-in during retrace is causing distortion at the ends of the display unit trace, depress this pushbutton to leave RF on during retrace. This is also recommended if power meters are used in the system.

3. 1 KHZ (4) : Use the 1 kHz square wave to amplitude-modulate the RF output for use with VSWR detectors or ratiometers.

4. VERNIER (L) : For fine frequency adjustments in CW and narrow Fc ± ΔF sweeps; read frequency up to 100 MHz which must be added to frequency indicated by the *RED* indicator on upper part of dial scale. VERNIER must be set to 0.0 (full ccw) to ensure accuracy of frequency readings.

Figure 3-2. Initial Operating Procedures (Sheet 3 of 3)

SECTION IV

PERFORMANCE CHECKS AND CALIBRATION

4-1. GENERAL

This section contains procedures for testing the electrical performance of the 5018 RF Plug-in and calibrating the unit when necessary.

Calibration accuracy checks should be undertaken only by qualified personnel with sufficient experience and knowledge to ensure that proper test methods are employed. Use standard maintenance and metrology practices when working on the plug-in.

4-2. PERFORMANCE CHECKS

This paragraph contains the performance check procedures listed in Table 4-1. These performance checks verify that the instrument meets the applicable performance specifications in Table 1-1. Failure to meet the specified performance limits indicates the need for repair or recalibration in accordance with the procedures of Paragraph 4-3.

The following performance checks may be made at any time, and should be performed annually in the order indicated. If these checks reveal the need for repair or recalibration of the instrument, it should be returned to Systron-Donner or another qualified metrology laboratory so that the calibration procedures in Paragraph 4-3 may be accomplished.

Table 4-1. Performance Checks

PARAGRAPH NUMBER	PROCEDURE	SPECIFICATION REFERENCE ITEM (TABLE 1-1)
4-2.4	Frequency Accuracy	2, 3
4-2.5	Power Output and External Leveling Flatness	5, 8
4-2.6	Unleveled Power Output and Flatness	5, 8
4-2.7	Residual Amplitude Modulation	11
4-2.8	Oscillator Pulling and Attenuation	4, 6
4-2.9	Residual Frequency Modulation	10
4-2.10	Spurious and Harmonic Content	9
4-2.11	Internal Amplitude Modulation	17

4-2.1 Equipment Required

The test equipment required to check performance of the plug-in is listed in Table 4-2. All test equipment should bear evidence of recent calibration by a qualified metrology laboratory. Equipment equivalent to that listed in Table 4-2 may be used, but care should be taken to ensure that the rated accuracy of the equipment used is truly equivalent to that cited. In any case, the maximum rated inaccuracy of a piece of test equipment used to measure any parameter should not be greater than one-fourth the maximum inaccuracy which can be tolerated in the measurement (this figure is recommended by the National Bureau of Standards). Test equipment of such accuracy may not be readily available for the 18 to 26.5 gigahertz band; allowances for test equipment error should be made in performance tests of the 5018.

4-2.2 Alternate Test Equipment

In many cases the recommended test equipment will not be available but alternate test equipment can be constructed from standard coaxial components and instruments.

4-2.2.1 POWER METER. The Hewlett-Packard 436A/8485A power meter/power sensor combination is listed because it is among very few power meters available with coaxial input in the 18 to 26.5 gigahertz band. The 8485A power sensor may also be used with the Hewlett-Packard 435A or 435B power meters.

Any high-quality power meter with a dynamic range of 40 decibels and temperature-compensated thermistor mount rated for operation in the 18 to 26.5 gigahertz band may be used. If the thermistor mount has a waveguide input, an appropriate coaxial to waveguide transition must be used. In that case, the loss and added VSWR of the transition must be taken into account when measuring 5018 output power.

4-2.2.2 DIRECTIONAL DETECTOR. If the specified directional detector is not available, an appropriate high-directivity coaxial coupler can be substituted. The coupling factor of the unit should be 6 decibels, and the coupled output must be fitted with a crystal detector rated for the same frequency range. The combined flatness error of the directional coupler and crystal detector should not exceed plus or minus one decibel over the 18 to 26.5 gigahertz frequency range.

A precision power divider with a loss of 6 decibels per port may be used for leveling applications, but the output power of the 5018 will be reduced accordingly. The power divider and crystal detector should have a combined flatness error not exceeding plus or minus one decibel in K-band.

4-2.2.3 CRYSTAL DETECTOR. The specified crystal detector is amond the few available coaxial devices for the 18 to 26.5 gigahertz band, but it does not have flat response in this band. The sensitivity decreases by about 50 percent (3 decibels) from 18 to 26.5 gigahertz. In addition, the detector has an allowable flatness variation of plus or minus 1.5 decibels from this predictable 3 decibel slope. A waveguide crystal detector and the specified waveguide-to-coaxial transition may be used instead of the Hewlett-Packard 8473C if the combined flatness error of the detector and transition is less than that of the specified coaxial crystal detector. In any case, the error of the crystal detector must be added to the allowed flatness error of the RF plug-in when measuring 5018 flatness errors.

4-2.2.4 CONNECTORS. All coaxial devices specified use precision 3.5-millimeter coaxial connectors, rather than SMA connectors. These two connector types will mate without damage, but the SMA connector will not be mode-free above 20 gigahertz. Typical of acceptable connector types for use in the 18 to 26.5 gigahertz range are: APC-3.5 (Amphenol), improved OSM (Omni Spectra), WPM-2 (Weinschel), and MPC3 (Maury Microwave). This list is not meant to be all-inclusive.

Table 4-2. Test Equipment Required for Performance Checks

ITEM	TYPE OF EQUIPMENT	CHARACTERISTICS	RECOMMENDED MODEL[1]
1	Sweeper Mainframe	5018-compatible	Systron-Donner 5000A[2]
2	Frequency Counter	18 to 26.5 GHz; 3.5 mm connector	Systron-Donner 6246A
3	Spectrum Analyzer	External mixer input; 10 kHz/ Div. resolution, 10 dB/Div.	Tektronix 492 with Option 02
4	Precision External Mixers for Spectrum Analyzer	18 to 60 GHz	Tektronix 492 Option 22
5	Precision External Mixer for Spectrum Analyzer[3]	60 to 90 GHz	Tektronix 016-0664-00
6	RF Adapter, WR-42 Waveguide to Coaxial	UG-595/U Flange to 3.5 mm; 18 to 26.5 GHz	Maury Microwave K210C
7	Waveguide Transition[3]	26.5 to 40 GHz; UG-595/U to UG-599/U Flange	Systron-Donner DBDE-018
8	Waveguide Transition[3]	40 to 60 GHz; UG-599/U to UG-383/U Flange	Any
9	Waveguide Transition[3]	60 to 90 GHz; UG-383/U to UG-387/U Flange	Any
10	Digital Voltmeter	Resolution 1 mV on 10 V scale	Systron-Donner 7344A (2 required)
11	Oscilloscope	High sensitivity with variable bandwidth	Tektronix 5403 mainframe, 5A22 vertical amplifier, 5B42 delaying time base
12	Sweep Voltage Attenuator	20:1; 1 kΩ minimum input impedance	Construct if oscilloscope with fixed 50 mV/Div. external sweep is used
13	RF Power Meter and Sensor	18 to 26.5 GHz; 3.5 mm connector	Hewlett-Packard 436A and 8485A
14	Directional Detector	18 to 26.5 GHz; 3.5 mm connectors, -10 mV/mW	Krytar 2616S
15	Crystal Detector	18 to 26.5 GHz; 3.5 mm connector, 0.4 mV/μW	Hewlett-Packard 8473C
16	RF Attenuator	3 dB, 18 to 26.5 GHz; 3.5 mm connectors	Weinschel 9-3
17	RF Attenuator[4]	20 dB, 18 to 26.5 GHz; 3.5 mm connectors	Weinschel 9-20
18	RF Cable, 18"	50 Ω, 18 to 26.5 GHz; 3.5 mm connectors, VSWR ≤ 1.7:1	W.L. Gore & Associates P7J01J01018.0
19	RF Cable, 24"	50 Ω; BNC to BNC	ITT Pomona 2249-C-24 (2 required)
20	RF Adapter	3.5 mm Male to 3.5 mm Male, 18 to 26.5 GHz	Omni Spectra 2781-0000-00
21	RF Adapter	BNC Tee	UG-274A/U
22	Feedthrough Termination	50 Ω, BNC	Tektronix 011-0049-01
23	Patch Cable, 24"	Dual banana plug to BNC	H.H. Smith 1584-24

[1] *Equipment having equivalent characteristics may be substituted*

[2] *Modified as noted in Section II of this manual*

[3] *Optional; refer to Paragraph 4-2.10 in this manual*

[4] *Required to reduce external mixer input amplitude to correct level*

4-2.3 Initial Setup

4-2.3.1 DESCRIPTION. Various controls are preset to desired positions to facilitate subsequent measurements. Connect the equipment and set controls as described below. Do not apply power at this time. All mainframe controls and functions called out in this or subsequent procedures are based upon Model 5000A markings and capabilities. If a mainframe other than Model 5000A is used, make the appropriate corrections in control names and positions. The mainframe markings and functions are similar enough so that no difficulty should be experienced in the translation.

4-2.3.2 PROCEDURE.

1. Install the RF plug-in and dial scale in accordance with the instructions in Section II; be sure to turn the locking knob cw to secure the 5018 in the mainframe.
2. Set the mainframe F1—START control to its maximum ccw position.
3. Set the mainframe F2—STOP control to its maximum cw position.
4. Set the MODE switch to CW.
5. Set the 5018 1 KHZ switch to OFF.
6. Set the LEVELER switch to OFF.
7. Set the RETRACE switch to OFF.
8. Set the MARKERS switch to OFF.
9. Set the RF LEVEL control to its maximum ccw position.
10. Set the mainframe VERNIER control to 0.0 (maximum ccw).
11. Turn on the mainframe power switch, then allow the units to warm up for 5 to 10 minutes.

4-2.4 Frequency Accuracy

4-2.4.1 DESCRIPTION. The RF output frequency is measured to ensure that the indicated and actual output frequencies are coincident within the specified tolerance.

NOTE

In order to obtain meaningful results, the dial accuracy of the mainframe must have been checked, and calibrated if necessary, immediately before beginning this procedure.

4-2.4.2 PROCEDURE Frequency accuracy should be checked at an ambient air temperature of +25°C (+77°F). When setting the frequency, take care to view the indicators straight on to eliminate parallax:

1. Using the Type APC-3.5 RF cable and 3-dB attenuator, connect the RF output of the plug-in to the input of the frequency counter as shown in Figure 4-1.

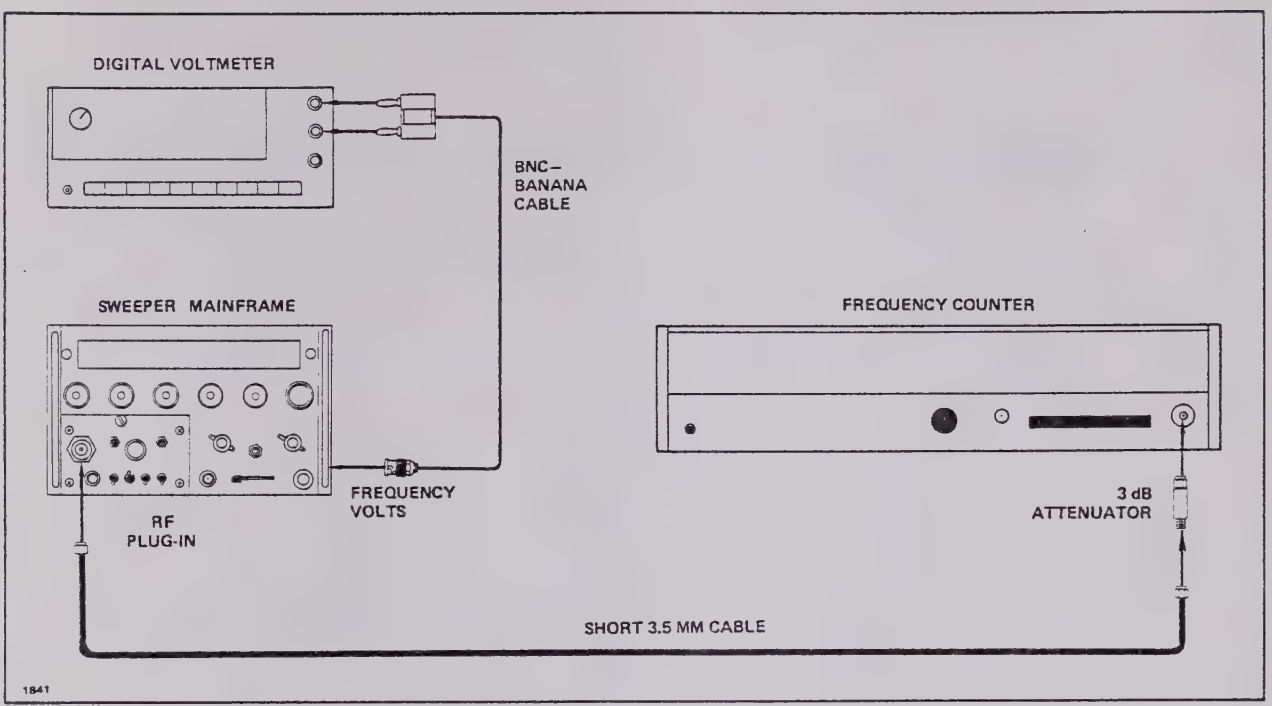


Figure 4-1. Test Setup for Frequency Accuracy Performance Checks

CAUTION

DAMAGE TO THE COUNTER MAY RESULT IF THE ATTENUATOR IS NOT USED.

2. Set the RF LEVEL control to 3.

3. Carefully set the MARKER 2—Fc control so that the *RED* indicator is aligned with the 18.0 GHz dial mark on the upper part of the scale.

4. The frequency counter must show 18.0 GHz ±265 MHz.

5. Repeat the test for as many dial marks as you wish to test (testing every 1,000 MHz is usually sufficient). The frequency tolerance must not exceed the dial accuracy specification of ±1% of the indicated frequency plus the basic frequency accuracy specification of ±85 MHz. (For example, at 20 GHz the tolerance is ±200 MHz ±85 MHz = ±285 MHz.)

6. Connect the digital voltmeter to the mainframe FREQ VOLTS jack.

7. Select the 10 Vdc range of the DVM.

8. Adjust the MARKER 2—Fc control for a DVM reading of –0.100 ±0.005 Vdc.

9. Verify the frequency counter shows 18,000 ±85 MHz.

10. Adjust the VERNIER control to its maximum cw stop (10.0).

11. Verify the frequency is 18,100 ±95 MHz.

12. Rotate the VERNIER control to its maximum ccw stop (0.0) and lock it in place for the rest of this procedure.

13. Adjust the MARKER 2—Fc control for a DVM reading of –2.585 ±0.005 Vdc.

14. Verify the frequency is 20,155 ±85 MHz.

15. Adjust the MARKER 2—Fc control for a DVM reading of –5.00 ±0.005 Vdc.

16. Verify the frequency is 22,250 ±85 MHz.

17. Adjust the MARKER 2—Fc control for a DVM reading of –7.415 ±0.005 Vdc.

18. Verify the frequency is 24,345 ±85 MHz.

19. Adjust the MARKER 2—Fc control for a DVM reading of –9.900 ±0.005 Vdc.

20. Verify the frequency is 26,500 ±85 MHz.

4-2.5 Power Output and External Leveling Flatness

4-2.5.1 DESCRIPTION. The minimum output power over the 18 to 26.5 GHz range of the 5018 is measured in leveled output mode using a matched directional detector. This procedure tests the 5018 and the leveling detector simultaneously. The 5018 may be performance-checked without using the external leveler; proceed directly to Paragraph 4-2.5.3.

4-2.5.2 PROCEDURE WITH EXTERNAL LEVELER.

1. Turn on the RF power meter and allow it to stabilize. The test setup at this time should be as shown in Figure 4-1.

2. Set the RF LEVEL control fully cw.

3. Set the 5000A SWEEP SECONDS switch to MANUAL SCAN.

4. Adjust the MANUAL SCAN control to maximum ccw rotation.

5. Set the F1—START control so the frequency counter reads 18,000 ±85 MHz.

6. Rotate the MANUAL SCAN control to maximum cw rotation.

7. Set the F2—STOP control so the counter reads 26,500 ±85 MHz.

8. Return the MANUAL SCAN control to maximum ccw and check the frequency reading; reset the F1—START control if necessary.

9. Remove the attenuator and counter input cable from the RF OUT connector of the 5018; connect the leveler and thermistor mount or power sensor of the power meter as shown in Figure 4-2.

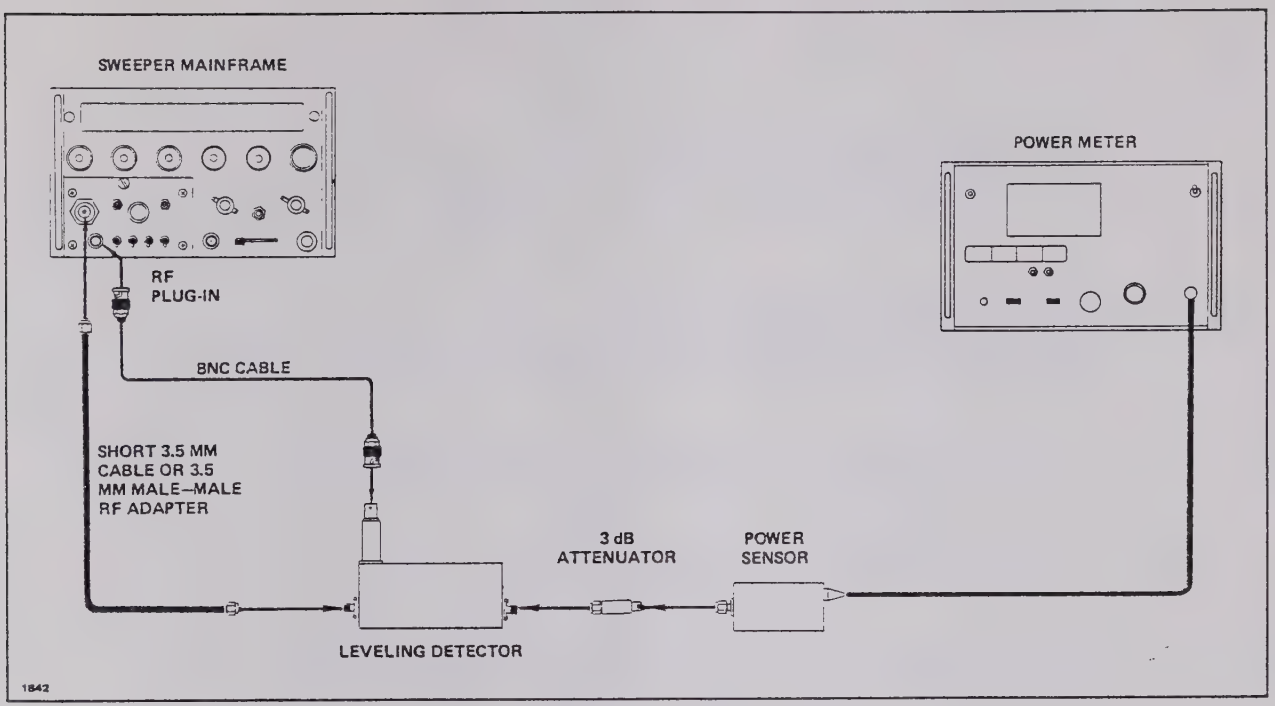


Figure 4-2. Test Setup for Output Power and External Leveling Flatness Performance Checks with External Directional Detector

IMPORTANT

The 3-dB attenuator must remain attached to the output connector of the leveler to reduce mismatch losses which might affect measurement accuracy and to avoid possible power meter damage.

10. Set the LEVELER switch to EXT.

11. Set the power meter to its 1 mW (0 dBm) range (not necessary if an auto-ranging power meter is used).

12. Slowly rotate the MANUAL SCAN control through its range; observe the power reading and locate the frequency at which the output amplitude is lowest.

13. Adjust the RF LEVEL control for a power level of exactly 1.0 mW (0 dBm). Because a 3-dB attenuator was used, the power meter reading will be 0.5 mW (−3 dBm).

14. Vary the MANUAL SCAN control over its full range again; check the power meter reading to ensure that the total power level increase over the band does not exceed 2.55 dB. This verifies the leveled flatness specification for the 5018 and the minimum output power specification of 1.0 mW for the 5018 when it is used with an external leveler having the characteristics of the recommended model.

IMPORTANT

This procedure does not allow for variations in the 3-dB attenuator. The worst-case combination of 5018, leveler, and attenuator error is $\leqslant \pm 2$ dB.

4-2.5.3 PROCEDURE WITHOUT EXTERNAL LEVELER.

1. Connect the test equipment as shown in Figure 4-3.
2. Set the 5000A **MODE** switch to **WIDE F1–F2**.
3. Set the **SWEEP SECONDS** switch to **.01** and the **SWEEP SECONDS VERNIER** control to **x1**.
4. Set the **LEVELER** switch to **EXT**.
5. Adjust the oscilloscope controls to accept the 0 to 10 V sweep ramp output of the 5000A for horizontal deflection.
6. Set the oscilloscope vertical channel preamplifier for 1 mV/Division. Establish a ground reference line on the oscilloscope trace.
7. Set the **RF LEVEL** control to the **0** marking.
8. Verify the oscilloscope trace is deflected less than 1 mV from the reference line.
9. Set the oscilloscope preamplifier controls for a sensitivity of 10 mV/Division.
10. Set the **RF LEVEL** control to the **1** marking.
11. Verify the oscilloscope trace is deflected 50 ±10 mV from the ground reference line over the entire X-axis graticule.

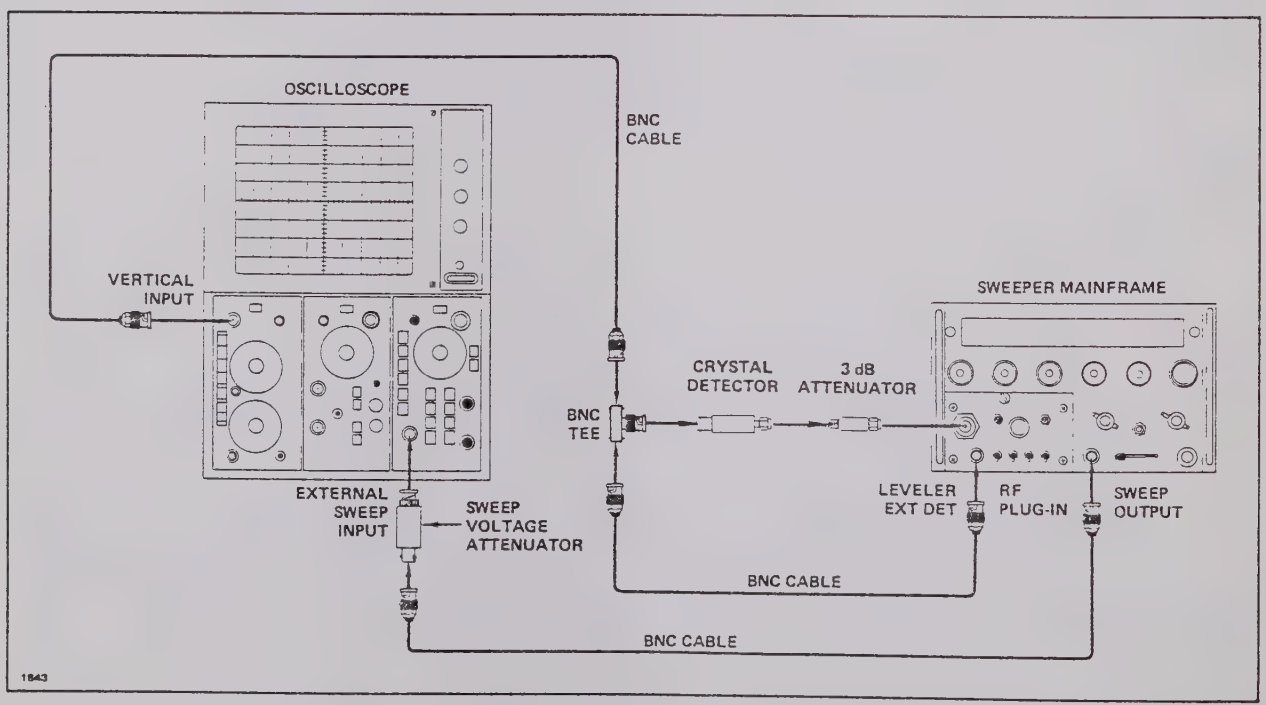


Figure 4-3. Test Setup for Output Power and External Leveling Flatness Performance Checks without External Directional Detector

12. Verify the deviation from a straight line on the trace does not exceed ±10 mV.

IMPORTANT

If the crystal detector is not flat over the 18 to 26.5 GHz range, you must add the uncertainty of the detector itself to the specified measurements in Steps *11* and *12*.

4-2.6 Unleveled Power Output and Flatness

4-2.6.1 DESCRIPTION. The peak output power amplitude is measured over the full frequency range of the plug-in to ensure conformance with minimum output power and flatness specifications.

4-2.6.2 PROCEDURE.

1. Connect the test equipment as shown in Figure 4-4.
2. Set the LEVELING switch to OFF.
3. Set the power meter to its 1 mW (0 dBm) range (not necessary if an auto-ranging power meter is used).
4. Set the RF LEVEL control to its maximum cw position; leave it at this position for the rest of the procedure.
5. Slowly vary the MANUAL SCAN control over its full range.
6. Set the power meter range switch to the position which allows the best resolution.
7. Check the power meter reading while manually scanning the entire band; note the maximum and minimum amplitudes.
8. Verify that the minimum power is $\geqslant$ 1.0 mW (0 dBm). Because a 3-dB attenuator was used, the power reading will be $\geqslant$0.5 mW (−3 dBm).
9. Verify that the maximum power variation (P_{max} — P_{min}) does not exceed 12 dB.
10. Set the MODE switch to CW.
11. Tune the MARKER 2—Fc control over the full range of 18 to 26.5 GHz. Verify the maximum power variation (P_{max} − P_{min}) does not exceed 3 dB/100 MHz.

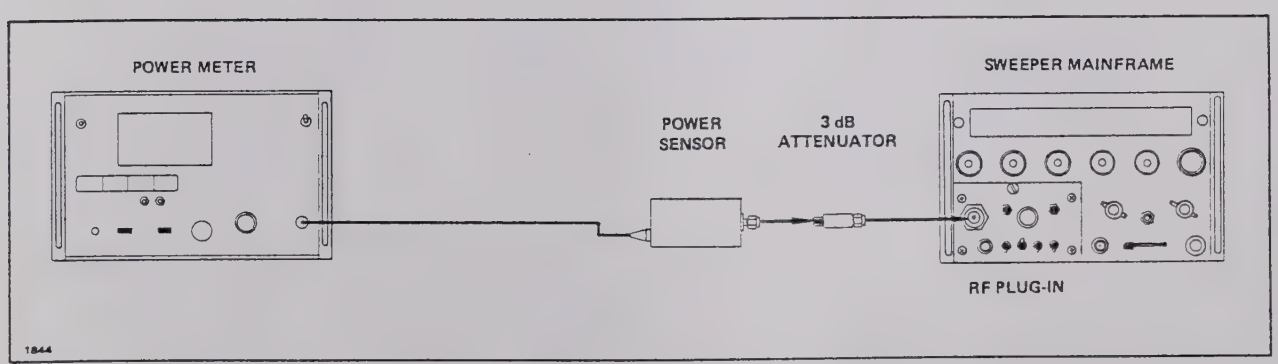


Figure 4-4. Test Setup for Unleveled Power Output and Flatness Performance Check

4-2.7 Residual Amplitude Modulation

4-2.7.1 DESCRIPTION. The content of unwanted amplitude modulation of the RF output signal is measured to ensure that it is not in excess of the specified value.

4-2.7.2 PROCEDURE.

1. Set the MODE switch to WIDE F1–F2.
2. Set the SWEEP SECONDS switch to MANUAL SCAN.
3. Set the F1–START control so the F1–START frequency indicator is at 18.0 GHz.
4. Set the F2–STOP control so the F2–STOP frequency indicator is at 26.5 GHz.
5. Connect the test equipment as shown in Figure 4-5.
6. Set the oscilloscope bandwidth controls for a lower limit of dc and an upper limit of 100 kHz.

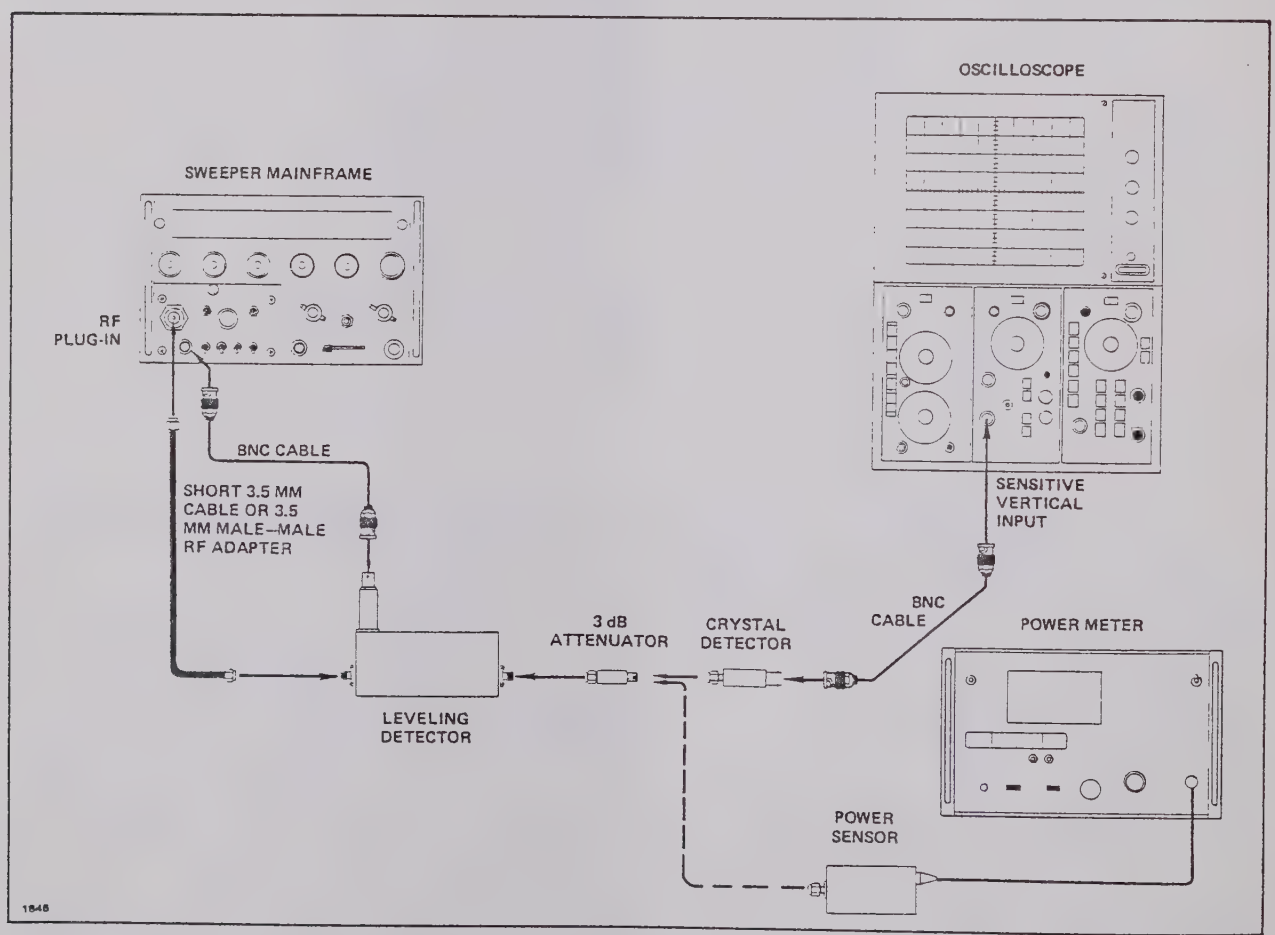


Figure 4-5. Test Setup for Residual Amplitude Modulation Performance Check

7. Set the oscilloscope time-base controls for an internally-generated free-running trace; use any convenient sweep rate.

8. Set the oscilloscope coupling to "ground" and carefully zero the trace.

9. Set the **LEVELER** switch to **OFF**.

10. Turn the **RF LEVEL** control fully cw.

11. Set the vertical sensitivity of the oscilloscope to 100 mV/Division.

12. Set the oscilloscope coupling switch to "dc".

13. Rotate the **MANUAL SCAN** control through its range to find the frequency at which the lowest power output occurs. Leave the **MANUAL SCAN** control in this position for the rest of this procedure.

14. Measure and note the dc amplitude of the detected RF output (V_O) at the minimum point.

15. Set the oscilloscope coupling switch to "ac" and the vertical sensitivity to 1 mV/Division.

16. Measure the peak-to-peak voltage of the detected waveform.

17. Divide the amplitude V_O noted in Step *14* by 200; verify that the signal level measured in Step *16* is *less* than this figure ($V_O \div 200 = 46$ dB).

18. Set the **RF LEVEL** control to **0**.

19. Remove the crystal detector from the output of the attenuator.

20. Connect a power meter to the output of the attenuator.

21. Adjust the **RF LEVEL** control for a power meter reading of 0.5 mW (–3 dBm). This sets the output level of the 5018 to the rated leveled output amplitude, taking the 3-dB attenuator into account.

22. Without changing the setting of the **RF LEVEL** control, disconnect the power meter from the output of the 3-dB attenuator and reconnect the crystal detector.

23. Set the oscilloscope coupling switch to "ground" and the vertical sensitivity to 50 mV/Division.

24. Carefully establish a zero trace reference, then set the oscilloscope coupling switch to "dc".

25. Set the **RETRACE** switch to **OFF**.

26. Measure and note the dc amplitude (V_O).

27. Set the oscilloscope coupling switch to "ac" and the vertical sensitivity to 1 mV/Division.

28. Measure the peak-to-peak value of the detected waveform.

29. Verify that the leveled mode residual AM index is at least 40 dB by dividing the amplitude V_o (Step *26*) by 100 ($V_o \div 100 = 40$ dB).

4-2.8 Oscillator Pulling and Attenuation

4-2.8.1 DESCRIPTION. The amplitude of frequency change from minimum to maximum output amplitude is measured to ensure that it does not exceed the specified maximum.

4-2.8.2 PROCEDURE.

1. Set the RF LEVEL control to 0.

CAUTION

BE SURE THE INPUT ATTENUATION OF THE SPECTRUM ANALYZER OR EXTERNAL MIXER IS 20 dB OR HIGHER.

2. Connect the equipment as shown in Figure 4-6. (If the basic spectrum analyzer will tune to 21 GHz without an external mixer, connect the output of the 5018 directly to it.)

3. If a direct connection to the analyzer is used, set the input attenuator to at least 20 dB.

4. Set the MODE switch to CW.

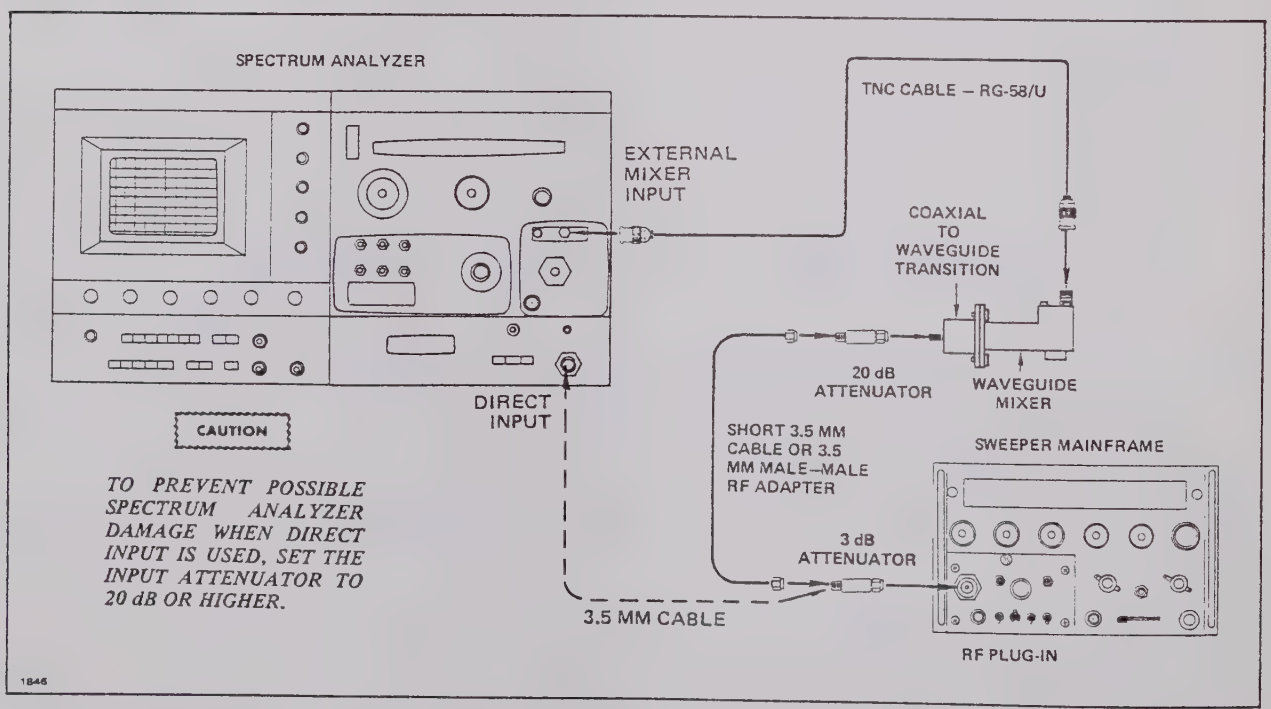

SPECTRUM ANALYZER
TNC CABLE – RG-58/U
EXTERNAL MIXER INPUT
COAXIAL TO WAVEGUIDE TRANSITION
20 dB ATTENUATOR
WAVEGUIDE MIXER
DIRECT INPUT
CAUTION
TO PREVENT POSSIBLE SPECTRUM ANALYZER DAMAGE WHEN DIRECT INPUT IS USED, SET THE INPUT ATTENUATOR TO 20 dB OR HIGHER.
SHORT 3.5 MM CABLE OR 3.5 MM MALE–MALE RF ADAPTER
SWEEPER MAINFRAME
3 dB ATTENUATOR
3.5 MM CABLE
RF PLUG-IN
1846

Figure 4-6. Typical Mixer Connection for Spurious and Harmonic Content Performance Check

5. Adjust the MARKER 2—Fc control for a frequency of 21 GHz.

6. Set the LEVELER switch to OFF.

7. Rotate the RF LEVEL control fully cw.

8. Tune the spectrum analyzer to 21 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

9. Adjust the spectrum analyzer controls to phase-lock the analyzer to the input signal.

10. Adjust the spectrum analyzer dispersion control(s) for 20 MHz/Division.

11. Carefully align the signal display with the center line of the spectrum analyzer horizontal axis.

12. Rotate the RF LEVEL control fully ccw.

13. Calculate the change in frequency. Verify the difference in frequency between maximum and minimum output amplitudes does not exceed 2.1 divisions. This is equivalent to a total change of 42 MHz at 21 GHz (±0.1%).

14. Verify the total amplitude change from maximum to minimum is at least 30 dB.

15. Connect an external leveler and set the LEVELER switch to EXT.

16. Verify the total amplitude change from maximum to minimum is at least 6 dB.

4-2.9 Residual Frequency Modulation

4-2.9.1 DESCRIPTION. The content of unwanted frequency changes in the continuous wave (CW) RF output signal is measured to ensure that it is below the allowable maximum.

4-2.9.2 PROCEDURE.

1. Set the RF LEVEL control to 0.

2. Connect the equipment as shown in Figure 4-2.

3. Set the spectrum analyzer input attenuator to 20 dB; this may be changed later.

4. Set the MODE switch to CW.

5. Adjust the MARKER 2—Fc control for a frequency of 21 GHz.

6. Set the SWEEP SECONDS switch to MANUAL SCAN.

7. Set the TRIG switch to MANUAL.

8. Set the RETRACE switch to ON.

9. Set the LEVELER switch to EXT.

10. Adjust the RF LEVEL control for a power meter reading of 0.5 mW (–3 dBm). This sets the output level of the plug-in to the rated leveled output amplitude, taking the 3-dB attenuator into account.

11. Without changing the setting of the RF LEVEL control, disconnect the power meter from the output attenuator.

CAUTION

BE SURE THE INPUT ATTENUATION OF THE SPECTRUM ANALYZER OR EXTERNAL MIXER IS 20 dB OR HIGHER.

12. Connect a cable between the output of the 3 dB attenuator and the external mixer 20 dB input attenuator. If the basic spectrum analyzer will tune to 21 GHz without an external mixer, connect the cable to the analyzer's direct input port. (Refer to Figure 4-6.)

13. Tune the spectrum analyzer to 21 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

14. Adjust the spectrum analyzer controls to phase-lock the analyzer to the input signal.

15. Adjust the spectrum analyzer dispersion control(s) for 50 kHz/Division.

16. Adjust the spectrum analyzer bandwidth control(s) to 30 kHz.

17. Set the sweep speed control(s) for a slow sweep, about 300 ms/Division.

18. As the spectrum analyzer CRT trace reaches the log reference level, measure the number of horizontal divisions covered by the trace at the logarithmic reference level; measure several cycles (refer to Figure 4-7).

19. Multiply the number of divisions covered by the trace at the peak level by the dispersion figure. Verify that the residual FM content is less than 40 kHz peak (less than 80 kHz peak-to-peak).

4-2.10 Spurious and Harmonic Content

4-2.10.1 DESCRIPTION. The content of unwanted spurious and harmonic outputs in the RF signal is measured to ensure conformance with the specified maxima.

4-2.10.2 PROCEDURE.

1. Set the RF LEVEL control to 0.

2. Connect the equipment as shown in Figure 4-2.

3. Set the spectrum analyzer input attenuator to 20 dB; this may be changed later.

4. Set the MODE switch to CW.

5. Adjust the MARKER 2—Fc control for a frequency of 18.0 GHz.

6. Set the SWEEP SECONDS switch to MANUAL SCAN.

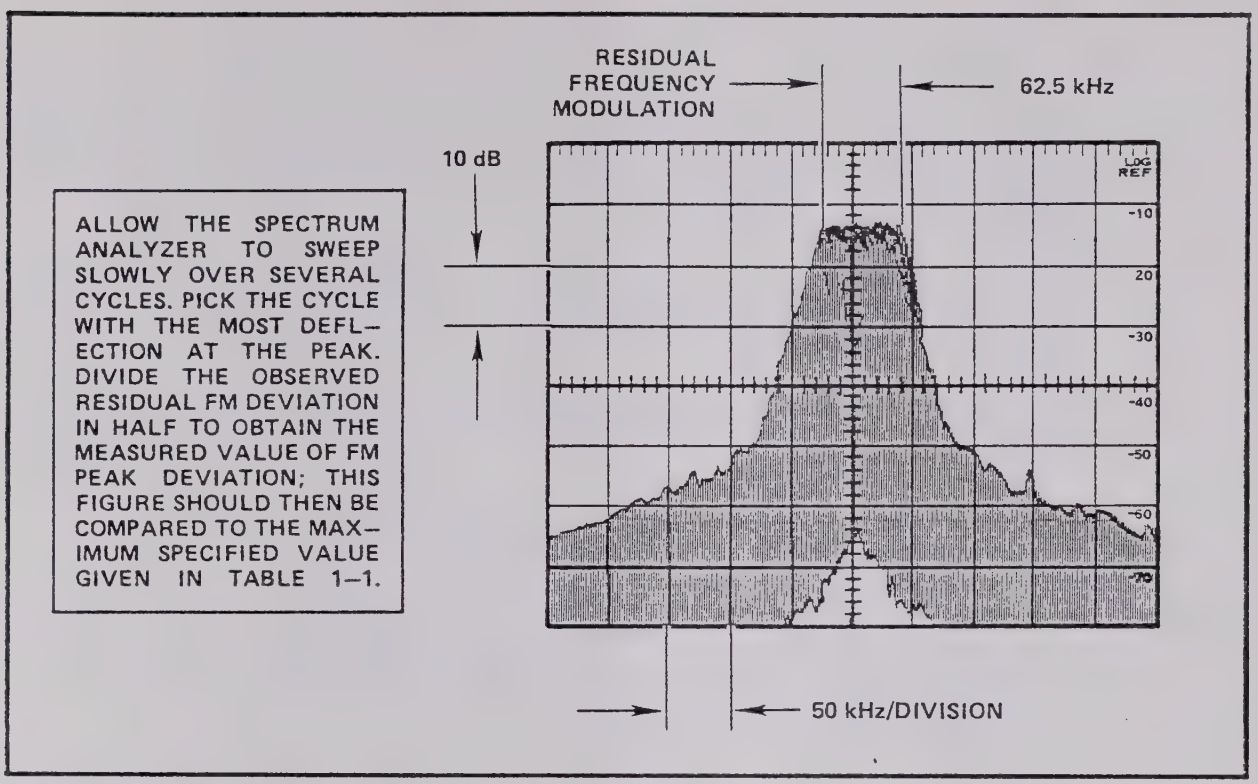

ALLOW THE SPECTRUM ANALYZER TO SWEEP SLOWLY OVER SEVERAL CYCLES. PICK THE CYCLE WITH THE MOST DEFL-ECTION AT THE PEAK. DIVIDE THE OBSERVED RESIDUAL FM DEVIATION IN HALF TO OBTAIN THE MEASURED VALUE OF FM PEAK DEVIATION; THIS FIGURE SHOULD THEN BE COMPARED TO THE MAX-IMUM SPECIFIED VALUE GIVEN IN TABLE 1-1.
RESIDUAL FREQUENCY MODULATION
62.5 kHz
10 dB
LOG REF
-10
20
-30
-40
-50
-60
-70
50 kHz/DIVISION

Figure 4-7. Typical Spectrum Analyzer Display of Residual FM

7. Set the TRIG switch to MANUAL.

8. Set the RETRACE switch to ON.

9. Connect an external leveler and set the LEVELER switch to EXT.

10. Adjust the RF LEVEL control for a power meter reading of 0.5 mW (−3 dBm). This sets the output level of the plug-in to the rated leveled output amplitude, taking the 3-dB attenuator into account.

11. Without changing the setting of the RF LEVEL control, disconnect the power meter from the output attenuator.

12. Connect a cable between the output of the 3 dB attenuator and the spectrum analyzer direct input or 20 dB attenuator, if an external mixer is used. (Refer to Figure 4-6.)

13. Tune the spectrum analyzer to 18.0 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

IMPORTANT

Be sure the input signal amplitude is not excessive. Spurious products generated within the spectrum analyzer by excessive input levels will compromise measurement accuracy.

14. Adjust the spectrum analyzer dispersion control(s) for 1 MHz/division.

15. Tune the spectrum analyzer over the frequency range of 18.0 to 26.5 GHz; use the spectrum analyzer manufacturer's recommended signal identification procedures to determine that any observed signal within 60 dB of the log reference level is "real" and not a spurious response generated within the spectrum analyzer. Ignore responses within 1 MHz of the carrier frequency.

16. Verify that any spurious responses within the 18.0 to 26.5 GHz band which are not generated within the spectrum analyzer, and are not within 1 MHz of the carrier frequency, are ⩾ 60 dB down from carrier level.

17. Tune the spectrum analyzer to 18.0 GHz; adjust the RF and IF attenuators for a display of the carrier aligned with the logarithmic reference line of the analyzer display.

NOTE

Harmonic measurements beyond the frequency coverage of the basic spectrum analyzer will require the use of external mixers and appropriate waveguide to coaxial adapters and/or waveguide transitions. The procedure may be terminated after Step *18* if the second harmonic of 18 GHz is ⩾ 30 dB below the log reference level. It is unlikely that any other harmonic will exceed the specified maximum.

18. Tune the spectrum analyzer to 36 GHz; verify the level of the second harmonic is ⩾ 30 dB below the log reference level.

19. Tune the spectrum analyzer to 54 GHz and verify the level of the third harmonic is ⩾ 30 dB down.

20. Adjust the MARKER 2—Fc control for a frequency of 26.5 GHz. Verify the second harmonic at 53 GHz and the third harmonic at 79.5 GHz are ⩾ 30 dB below the carrier level.

4-2.11 Internal Amplitude Modulation

4-2.11.1 DESCRIPTION. The frequency and symmetry of the internal square wave generator are tested for conformance to specifications; square wave rise and fall times in the demodulated output are analyzed to ensure leveling loop response is within specification.

4-2.11.2 PROCEDURE.

1. Rotate the RF LEVEL control of the 5018 to its maximum ccw position.

2. Connect the equipment as shown in Figure 4-8, with the BNC cable connecting the rear-panel 1 KHZ jack of the mainframe to the low-frequency input of the counter.

3. Set the LEVELER switch to OFF.

4. Set the 1 KHZ switch to ON.

5. Set the mainframe MODE switch to CW.

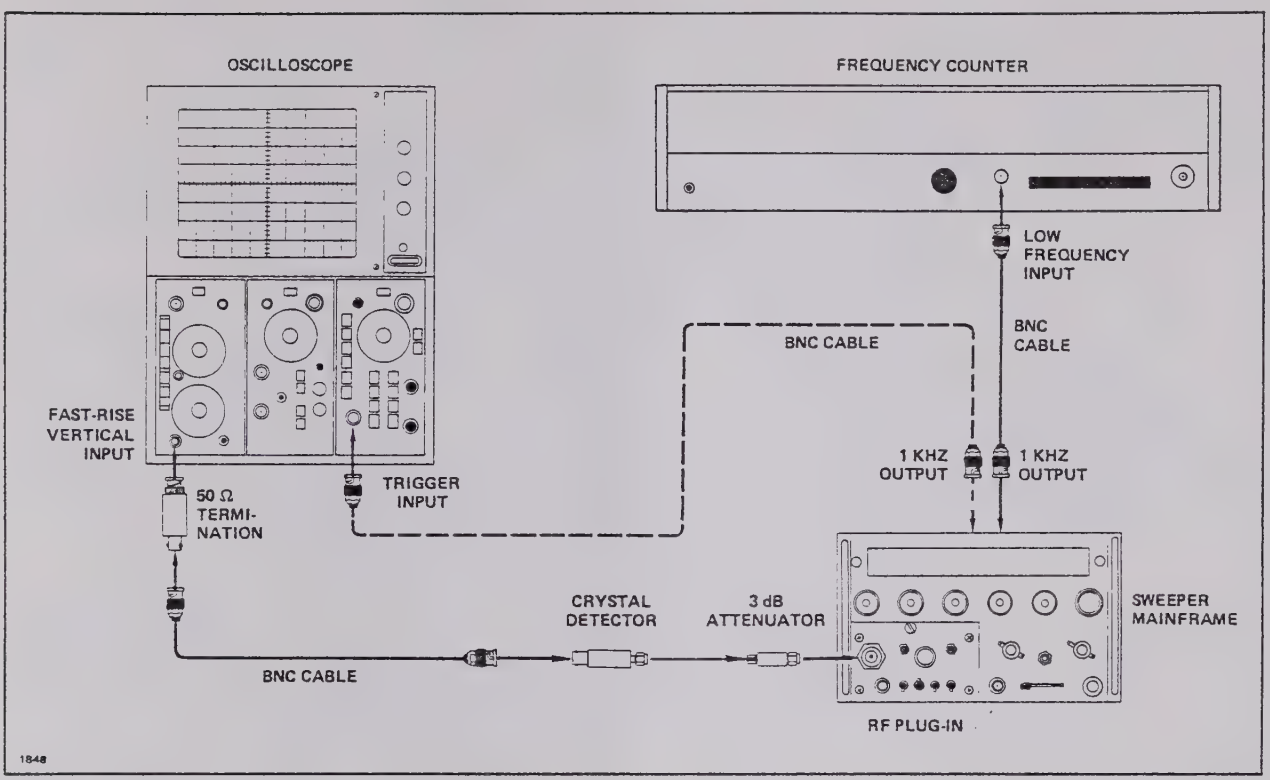


Figure 4-8. Test Setup for Internal Amplitude Modulation Performance Check

6. Adjust the MARKER 2—Fc control for a mid-band output frequency, about 22 GHz.

7. Increase the setting of the RF LEVEL control to 1.

8. Rotate the 1 KHZ ADJ control fully ccw. Verify the frequency is $\leqslant$ 950 Hz.

9. Rotate the 1 KHZ ADJ control fully cw and verify the frequency is $\geqslant$ 1050 Hz.

10. Set the 1 KHZ ADJ control to produce an output frequency of 1000 ±5 Hz.

11. Move the 1 kHz input cable from the frequency counter to the "external trigger" input of the oscilloscope delaying time base.

12. Measure the 10% to 90% risetime of the leading edge of the detected 1 kHz square wave. Verify that T_r is $\leqslant$ 10 μs (refer to Figure 4-9).

13. Verify that the 90% to 10% fall time of the trailing edge of the waveform is $\leqslant$ 10 μs, as shown in Figure 4-9.

14. Verify that the symmetry error of the detected square wave does not exceed 5%:

    a. Symmetry error (D) is defined as the percentage difference between the ratio of "on" time (T_{on}) less one-half the period time (T) of a single complete square wave cycle to one-half the period time (see Figure 4-9).

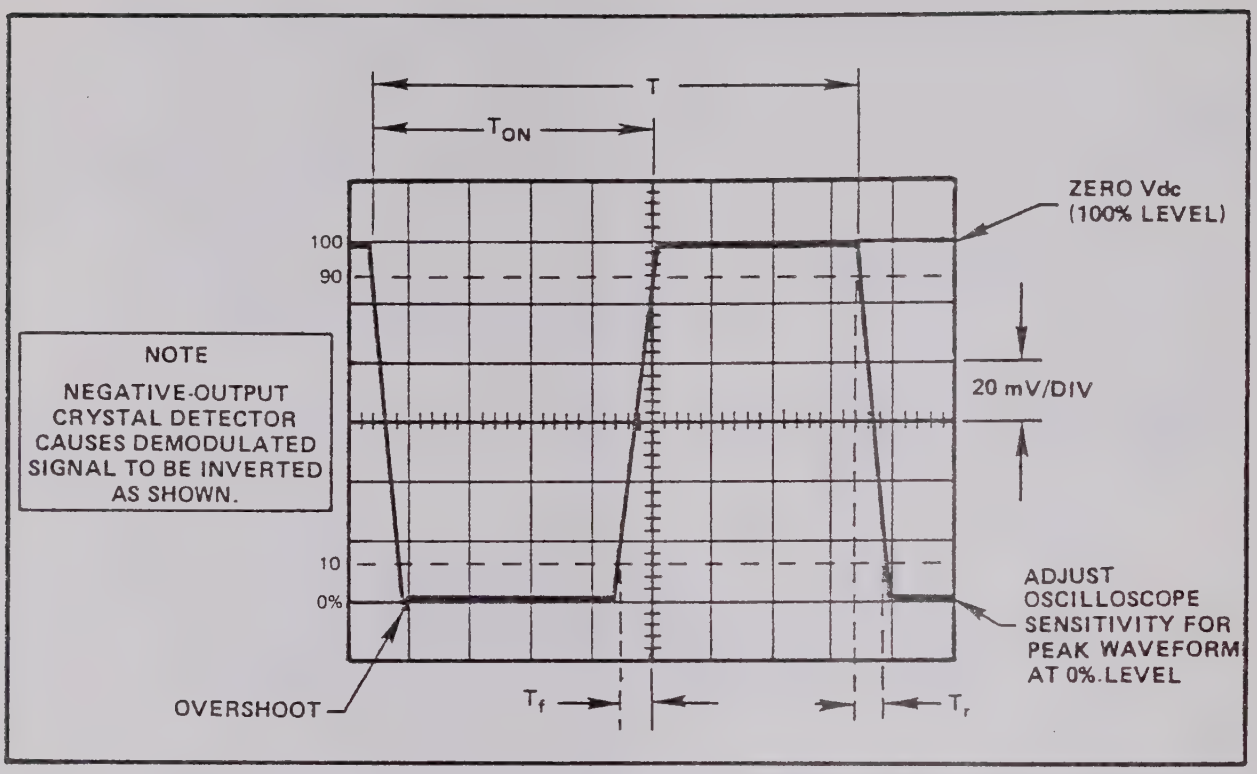


Figure 4-9. Demodulated Square Wave Characteristics

b. Measure the total period time of one detected square wave.

c. Measure the period of the "on" half of the cycle.

d. Solve the equation:

$$D = \frac{T_{on} - 0.5\,T}{0.5\,T} \times 100$$

4-3. CALIBRATION

4-3.1 General

This paragraph contains instructions for calibrating the internal circuitry of the Model 5018; these procedures are listed in Table 4-3. Recalibration is necessary after parts have been replaced or when periodic performance checks reveal out-of-tolerance conditions.

Several procedures which are not required during normal calibration are also listed in Table 4-3 for the convenience of calibration personnel; these procedures relate to the selection of certain fixed-value components which may be necessary after the replacement of an oscillator or RF modulator assembly or after replacement of critical components in the circuitry of the 5018.

4-3.2 Equipment Required for Calibration

Table 4-4 lists items of test equipment required for calibration of the 5018 RF Plug-in.

Table 4-3. Calibration Procedures

FUNCTION	CONTROL OR COMPONENT	LOCATION	REFERENCE PARAGRAPH
ROUTINE FREQUENCY CALIBRATION NOT INVOLVING COMPONENT REPLACEMENT REQUIRES ADJUSTMENT OF A1R40, A1R11, AND A1R30 ONLY.			
Oscillator Start Frequency Adjust	R40	A1 Oscillator Driver	4-3.5
Oscillator Stop Frequency Adjust	R11	A1 Oscillator Driver	4-3.5
Oscillator Tuning Current Limit Adjust	R30	A1 Oscillator Driver	4-3.5
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW IS NECESSARY AFTER REPLACEMENT OF OSCILLATOR MODULE Y1.			
Oscillator V_b Set	R35, R37	A1 Oscillator Driver	4-3.7
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW MAY BE NECESSARY AFTER REPLACEMENT OF OSCILLATOR MODULE Y1 OR A FAULTY A1 BOARD COMPONENT.			
Oscillator V_b Lower Limit Set	R46	A1 Oscillator Driver	4-3.7
Oscillator Stop Frequency Range Adjust	R13	A1 Oscillator Driver	4-3.8
Oscillator Start Frequency Adjust	R41, R43	A1 Oscillator Driver	4-3.8
Oscillator Tuning Current Limit Range Adjust	R28, R29	A1 Oscillator Driver	4-3.8
SELECTION OF FIXED COMPONENT VALUES LISTED BELOW MAY BE NECESSARY AFTER REPLACEMENT OF MODULATOR AT1, OSCILLATOR MODULE Y1, OR A FAULTY A2 BOARD COMPONENT.			
Leveled Amplitude Zero	R25, R26	A2 Leveler	4-3.9
Leveled Amplitude Maximum	R14	A2 Leveler	4-3.9
Leveling Loop Stability	C8	A2 Leveler	4-3.9
Leveling Loop Response	C1	A2 Leveler	4-3.9
1 kHz Symmetry	R37	A2 Leveler	4-3.10

Table 4-4. Test Equipment Required for Calibration

ITEM	TYPE OF EQUIPMENT	CHARACTERISTICS	RECOMMENDED MODEL[1]
1	Sweeper Mainframe	5018-compatible	Systron-Donner 5000A[2]
2	Plug-in Extender	5018-compatible	Systron-Donner 9202
3	Plug-in Inverter	5018-compatible	Systron-Donner 9203
4	Frequency Counter	18 to 26.5 GHz; 3.5 mm connector	Systron-Donner 6246A
5	Digital Voltmeter	Resolution 1 mV on 10 V scale	Systron-Donner 7344A (2 required)
6	Oscilloscope	High sensitivity with variable bandwidth	Tektronix 5403 mainframe, 5A22 vertical amplifier, 5B42 delaying time base
7	Sweep Voltage Attenuator	20:1; 1 kΩ minimum input impedance	Construct if oscilloscope with fixed 50 mV/Div. external sweep is used
8	RF Power Meter and Sensor	18 to 26.5 GHz; 3.5 mm connector	Hewlett-Packard 436A and 8485A
9	Directional Detector	18 to 26.5 GHz; 3.5 mm connectors, -10 mV/mW	Krytar 2616S
10	Crystal Detector	18 to 26.5 GHz; 3.5 mm connector, 0.4 mV/μW	Hewlett-Packard 8473C
11	RF Attenuator	3 dB, 18 to 26.5 GHz; 3.5 mm connectors	Weinschel 9-3
12	RF Cable, 18"	50 Ω, 18 to 26.5 GHz; 3.5 mm connectors, VSWR ≤ 1.7:1	W.L. Gore & Associates P7J01J01018.0
13	RF Cable, 24"	50 Ω; BNC to BNC	ITT Pomona 2249-C-24 (3 required)
14	RF Adapter	3.5 mm Male to 3.5 mm Male, 18 to 26.5 GHz	Omni Spectra 2781-0000-00
15	RF Adapter	BNC Tee	UG-274A/U
16	Feedthrough Termination	50 Ω, BNC	Tektronix 011-0049-01
17	Precision DC Power Supply	Adjustable 0 to 12 ± 0.05 Vdc; ungrounded output	Systron-Donner PLS 50-1 or M107
18	Decade Resistance Box	1 Ω to 1 MΩ ± 1%	Heathkit IN-3117 (4 required)
19	Patch Cable, 24"	Dual banana plug to BNC	H.H. Smith 1584-24
20	Patch Cable, 24"	Dual banana plug to dual banana plug	ITT Pomona 23A-24 (2 required)
21	Test Cable, 24"	Dual banana plug to miniature test clips	ITT Pomona 3786-C-24 (3 required)

[1] *Equipment having equivalent characteristics may be substituted*

[2] *Modified as noted in Section II of this manual*

4-3.3 Access to Calibration Components

4-3.3.1 ROUTINE FREQUENCY CALIBRATION. The test technician must have access to the calibration potentiometers mounted on the bottom of Oscillator Driver Board A1 in order to perform routine frequency calibration of the 5018. Because of the high currents (up to one ampere) required from the mainframe power supplies, long extension cables which may be satisfactory for trouble isolation and repair should not be used in frequency calibration. Voltage drops on the extension cable wires and connector contacts will adversely affect the calibration accuracy.

Model 5000A Mainframe. It is not necessary to use an extender to gain access to the 5018 frequency calibration controls:

1. Turn off mainframe power.
2. Remove the bottom cover of the mainframe.
3. Lay the mainframe on its side.
4. Do not operate the units for more than ten minutes in this configuration.
5. Perform routine calibration detailed in Paragraph 4-3.5.1.

Model 540 or 540B Mainframe with 579 Adapter. Inverter Model 9203 is required to perform routine frequency calibration:

1. Turn off mainframe power.
2. Remove the top cover of the mainframe.
3. Remove the 579 Adapter.
4. Remove the top cover of the 579 Adapter.
5. Install the 579 Adapter in the 540-series mainframe.
6. Connect the 9203 Inverter to the 579 interface connector.
7. Connect rear-panel interface connector P20 of the 5018 to the mating interface connector of the 9202 Extender.
8. Lay the mainframe on its side .
9. Do not operate the units for more than ten minutes in this configuration.
10. Perform routine calibration detailed in Paragraph 4-3.5.2.

4-3.3.2 SELECT-BY-TEST CALIBRATION. It may be necessary to replace certain fixed-value resistors or capacitors after replacement of critical components. If calibration beyond routine frequency adjustment is required, the 5018 should be opened as shown in Figure 4-10 to allow access to the components of printed circuit boards A1 and A2. The disassembly sequence is shown in Figure 4-11.

1. Remove two No. 6-32 Oval-head Phillips screws (1) from the top of the front panel.

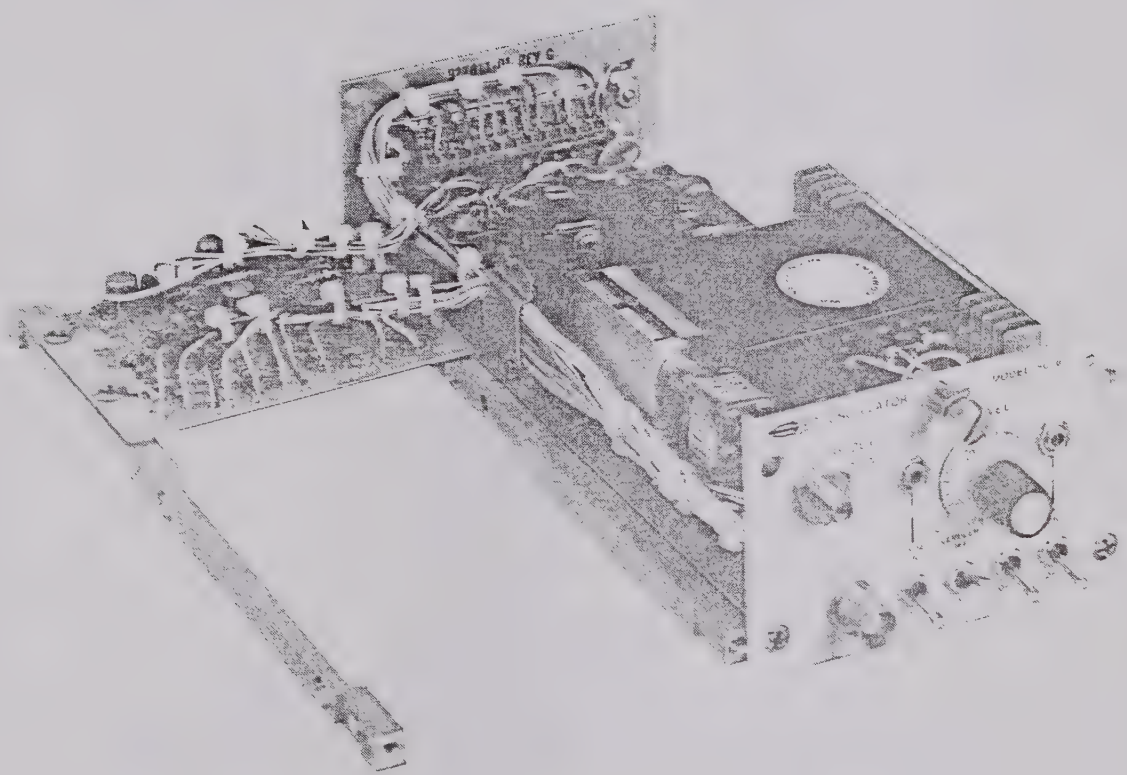


Figure 4-10. Service and Select-by-Test Calibration Configuration

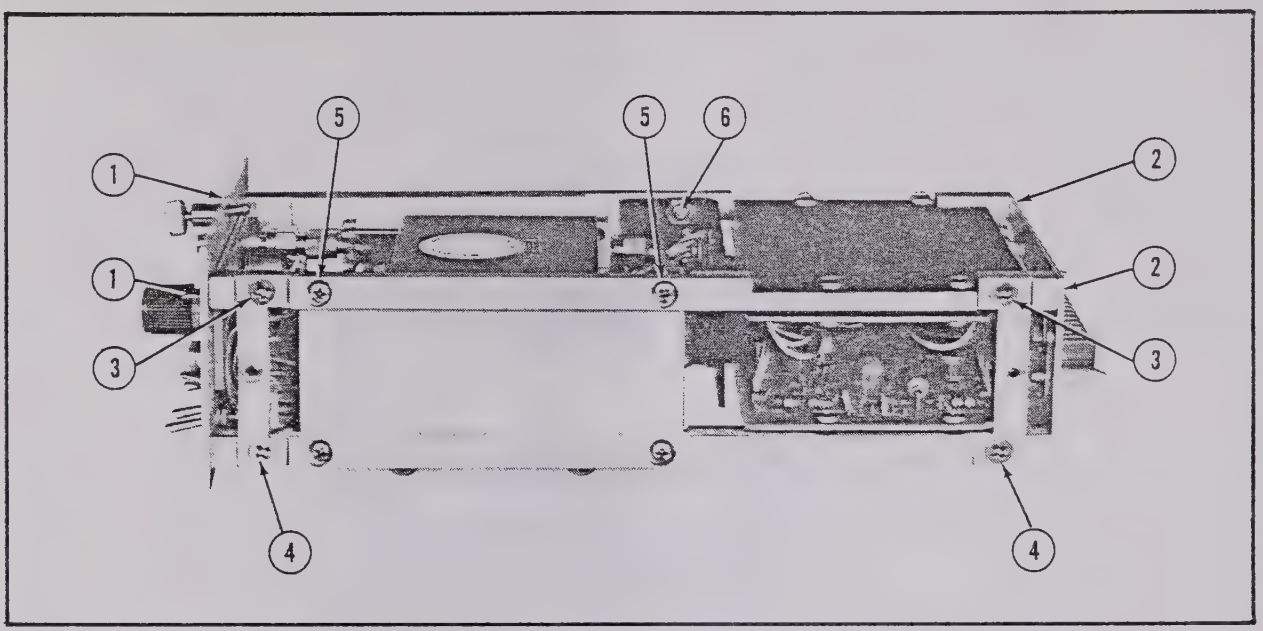


Figure 4-11. Disassembly Sequence for Service and Select-by-Test Calibration

2. Remove two No. 6-32 Flat-head Phillips screws (2) from the top of the rear panel.

3. Remove two No. 6-32 Flat-head Phillips screws (3) from the left top mounting bar.

4. Loosen, but do not remove two No. 6-32 Flat-head Phillips screws (4) from the left bottom mounting bar.

5. Remove two No. 4-40 pan-head screws (5) from the left top mounting bar.

6. Remove one No. 6-32 Fillister-head screw (6) from the right top mounting bar.

7. Grasp the top mounting rails and gently pull up to clear the oscillator module and modulator.

8. Rotate the top mounting rails and A2 board assembly to the right side of the 5018. It may be necessary to cut one or more of the nylon cable ties so that the mounting rails and A2 can be fully rotated as shown in Figure 4-11.

CAUTION

USE CARE WHEN CUTTING THESE TIES TO AVOID NICKING OR CUTTING ANY OF THE WIRES. DO NOT STRAIN OR BREAK ANY WIRES SOLDERED TO THE A2 BOARD.

9. Attach the 5018 to the interface connector of the 9202 Extender. In Model 5000A and some other mainframes, it may be necessary to remove the right-front corner block and handle if any interference is experienced when the 5018 is connected.

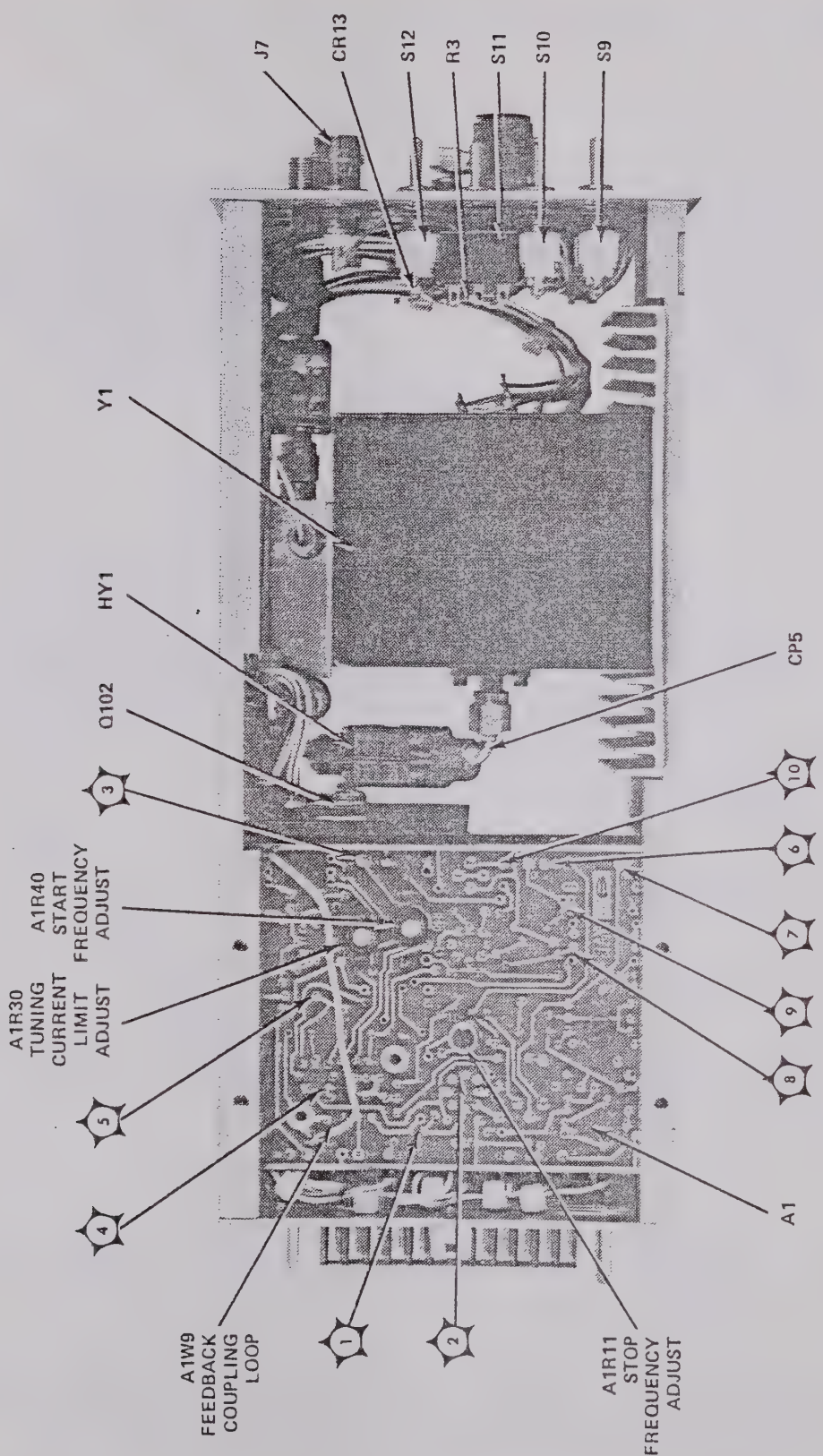


Figure 4-12. Location of Components, Adjustments, and Reference Test Points (Sheet 1 of 2)

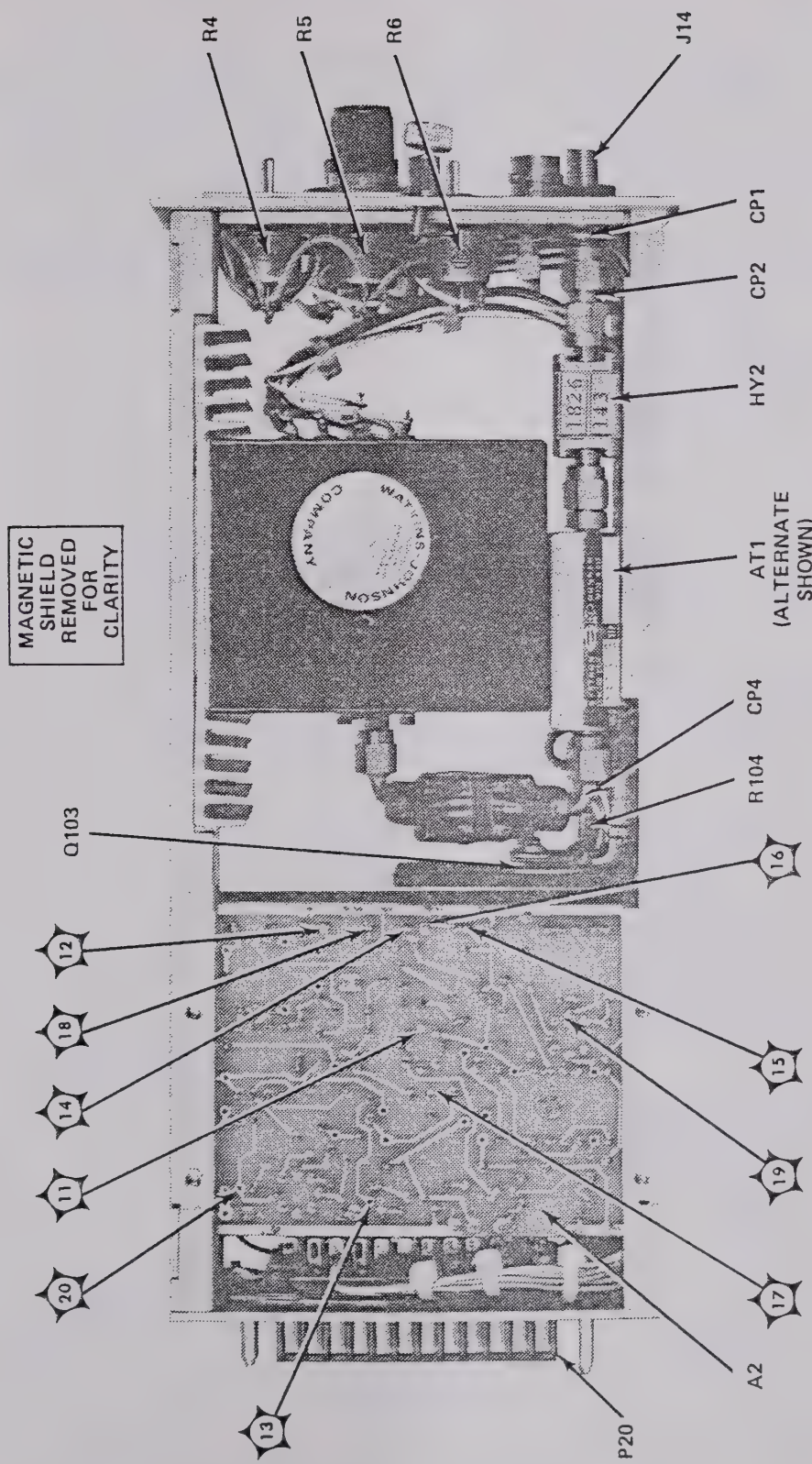


Figure 4-12. Location of Components, Adjustments, and Reference Test Points (Sheet 2 of 2)

4-3.4 Location of Components and Adjustments

As an aid to calibration and repair, the locations of major components and subassemblies and all reference test points and adjustments are shown in Figure 4-12. The reference test points shown are component leads and interconnection eyelets; the 5018 does not utilize test point devices. The electrical locations of these reference test points are shown in the schematic diagrams of Oscillator Driver Board A1 (Figure 8-3) and Leveler/AM Board A2 (Figure 9-3).

The adjustment potentiometers are designed to be operated with a small plastic screwdriver. Do not attempt to force a potentiometer if resistance is met, and do not use lacquer, enamel, or any other sealer to hold the potentiometer in place after adjustment.

4-3.5 Routine Frequency Calibration

4-3.5.1 5000A MAINFRAMES.

1. Turn off mainframe power.
2. Connect the test equipment as shown in Figure 4-13.
3. Turn on mainframe power and all test equipment. Allow at least 5 minutes for the equipment to stabilize.
4. Preset *A1R30 TUNING CURRENT LIMIT ADJUST* (Figure 4-12) to maximum ccw rotation.
5. Set the mainframe MODE switch to CW.

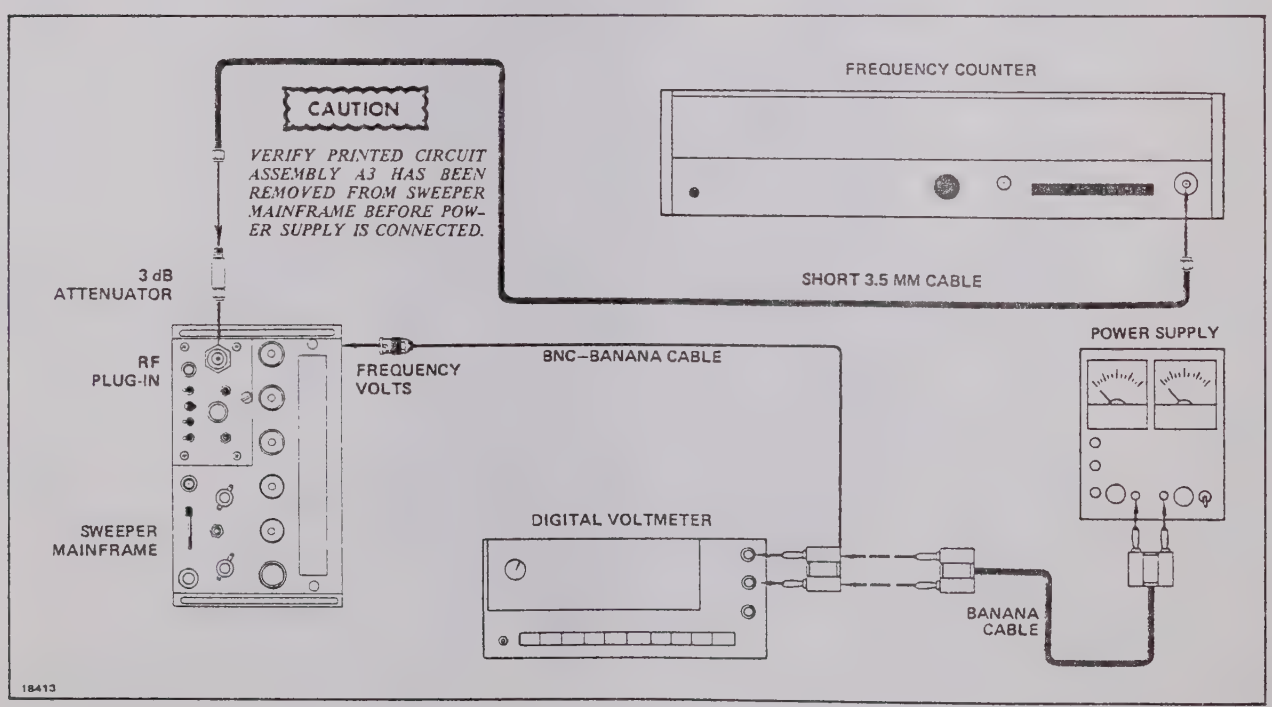


Figure 4-13. Test Setup for Frequency Calibration in 5000A

6. Set the 5018 **1 KHZ** switch to **OFF**.

7. Set the 5018 **LEVELER** switch to **OFF** and the **RF LEVEL** control to **3**.

8. Rotate the **VERNIER** control to mid-range.

9. Adjust the **MARKER 2—Fc** and **VERNIER** controls for a digital voltmeter reading of –0.100 ±0.005 Vdc.

10. Adjust *A1R40 START FREQUENCY ADJUST* (Figure 4-12) for a counter reading of 18,000 ±50 MHz.

11. Adjust the **MARKER 2—Fc** and **VERNIER** controls for a DVM reading of –9.900 ±0.005 Vdc.

12. Adjust *A1R11 STOP FREQUENCY ADJUST* (Figure 4-12) for a counter reading of 26,500 ±50 MHz.

13. Repeat Steps *9* through *12*.

14. Press the **PUSH ON-OFF** switch to turn off mainframe power.

15. Remove printed circuit board assembly A3 Operational Amplifier from its mating connector in the mainframe.

16. Adjust the output of the power supply to zero, then connect the output cable of the power supply to the input terminals of the digital voltmeter. Be sure to connect the + output of the power supply to the DVM – terminal and the power supply – output to the DVM + terminal.

17. Press the **PUSH ON-OFF** switch to turn on mainframe power; allow the mainframe and 5018 to warm up for about 5 minutes.

18. Adjust the power supply voltage for a DVM reading of –10.50 ±0.01 Vdc.

19. Set *A1R30 TUNING CURRENT LIMIT ADJUST* until the counter reading jumps to ≈ 26.6 GHz. Increase the power supply output to –11.00 ±0.05 Vdc and verify that the frequency reading does not increase significantly.

20. Turn off mainframe power.

21. Turn off the power supply, then disconnect it from the DVM and mainframe.

22. Re-install printed circuit assembly A3 in the mainframe.

23. Turn on mainframe power.

24. Repeat Steps *9* through *22*.

4-3.5.2 540 AND 540B MAINFRAMES/579 ADAPTER.

1. Turn off mainframe power.

2. Connect the test equipment as shown in Figure 4-14.

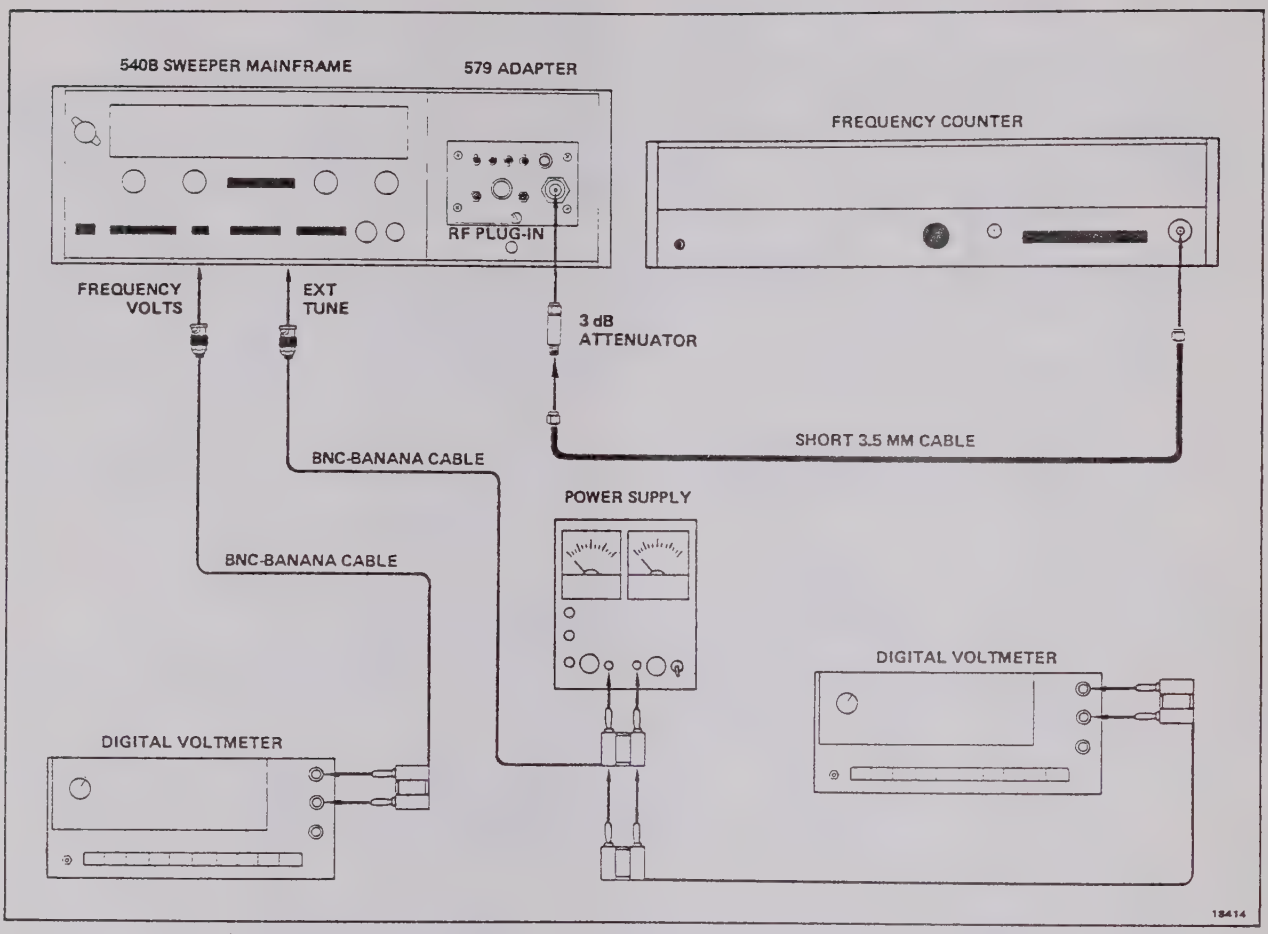


Figure 4-14. Test Setup for Frequency Calibration in 540B/579

3. Turn on mainframe power and all test equipment. Allow at least 5 minutes for the equipment to stabilize.

4. Preset *A1R30 TUNING CURRENT LIMIT ADJUST* (Figures 4-12) to maximum ccw rotation.

5. Set the 5018 **1 KHZ** switch to **OFF**.

6. Set the 5018 **LEVELER** switch to **OFF** and the **RF LEVEL** control to **3**.

7. Depress and latch the **CW MODULATION MODE** pushbutton.

8. Depress and latch the mainframe **CW SWEEP MODE** pushbutton.

9. Adjust the **Fc/CW** control for a digital voltmeter reading of –0.100 ±0.005 Vdc.

10. Adjust *A1R40 START FREQUENCY ADJUST* (Figure 4-12) for a counter reading of 18,000 ±50 MHz.

11. Adjust the Fc/CW control for a DVM reading of –9.900 ±0.005 Vdc.

12. Adjust *A1R11 STOP FREQUENCY ADJUST* (Figure 4-12) for a counter reading of 26,500 ±50 MHz.

13. Repeat Steps *9* through *12*.

14. Adjust the output of the power supply to zero.

15. Depress and latch the EXT TUNE pushbutton.

16. Adjust the power supply voltage for a DVM reading of –10.50 ±0.01 Vdc.

17. Set *A1R30 TUNING CURRENT LIMIT ADJUST* (Figure 4-12) until the counter reading jumps to ≈ 26.6 GHz. Increase the power supply output to –11.00 ±0.05 Vdc and verify that the frequency reading does not increase significantly.

18. Repeat Steps *8* through *17*.

4-3.6 General Procedure for Selection of Component Values

Paragraphs 4-3.7 through 4-3.11, following, contain test procedures which require the selection of fixed-value components to accomplish a particular calibration goal. These procedures may be completed more easily if simple practices are followed:

1. When a calibration resistor is removed and replaced with a resistance substitution box, it is generally best to cut the fixed resistor out of the circuit next to the body of the resistor. Use the resistor leads as connecting points for test leads from the resistance substitution box. This will avoid stressing the printed circuit board material and traces with repeated soldering/desoldering operations.

2. When determining resistance value with a decade box or resistance substitution box, always set the decade box to a standard resistance value (e.g., 47 kΩ, 62 kΩ, etc.). Do not cause yourself unnecessary trouble by calibrating to unavailable component values (e.g., 64 kΩ, 46 kΩ, etc.).

3. Where two select-by-test calibration resistors are wired in parallel, one is used as a "trimming" value for the other. It is expected that one of the resistors will be set to a relatively low value (in terms of the other resistor) and the parallel resistance will be relatively high in value. Again, only standard resistance values should be used in this situation, although the resulting resistance value in the circuit of the two components will probably not be a standard value.

4-3.7 Oscillator Bias Voltage Setting

4-3.7.1 DESCRIPTION. It may be necessary to recalibrate the level of the power source (bias) for the oscillator module under any of the following circumstances:

1. Following replacement of a defective oscillator module

2. Following replacement of Q102, A1U7, A1VR7, or other components in the circuitry around A1U7

3. If oscillator performance is unreliable (loss of output power when sweeping in reverse from high to low frequency, lack of output power when mainframe power is turned on with CW frequency set above 25 GHz, or output power below specified minimum amplitude above 23 GHz)

This procedure is valid for all current production versions of the 5018 equipped with a Watkins-Johnson oscillator module Y1. All replacement oscillators require *programming* of the operating bias voltage (V_b) to obtain maximum output power over the full frequency range of the 5018. The oscillator nameplate or the test data sheet supplied with the oscillator will specify two voltages. The first voltage listed is the optimum V_b at 18 gigahertz; the second voltage listed is the V_b at 26.5 gigahertz.

4-3.7.2 PROCEDURE.

1. Put the 5018 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Disconnect the white/green wire from the + VDC terminal of oscillator module Y1.

3. Remove resistor A1R35 (Figure 4-15) and connect a resistance decade box in its place. Set the resistance value to match the removed resistor.

4. Remove resistor A1R37 (Figure 4-15) and connect a second resistance decade box in its place. Set the resistance value to match the removed resistor.

5. Remove resistor A1R45 (Figure 4-15) and connect the third resistance decade box in its place. Set the value to match the removed resistor.

6. Install a Zener diode in place of A1VR9 on the oscillator driver board (see Figure 4-15). The new diode must have the following characteristics:

   a. Tolerance of ±5% or less

   b. Wattage rating of 1 W

   c. Voltage rating shall be $\approx$ 1.5 Vdc above the maximum rated oscillator operating voltage. In no case shall the voltage of the diode be $<$ 1.0 Vdc or $>$ 2.0 Vdc above the rated operating voltage. In practice, the next standard JEDEC value above the oscillator voltage rating is usually used (if the maximum oscillator voltage is +10.8, a 12-volt diode would be used).

7. Connect the positive test lead from one DVM to the white/green wire removed from the oscillator in Step 2.

8. Connect the negative DVM test lead to the chassis of the 5018.

9. Connect a second DVM to the mainframe FREQUENCY VOLTS jack.

10. Preset the 5018 frequency calibration adjustments:

    a. A1R40 center of rotation

    b. A1R11 center of rotation

    c. A1R30 maximum ccw

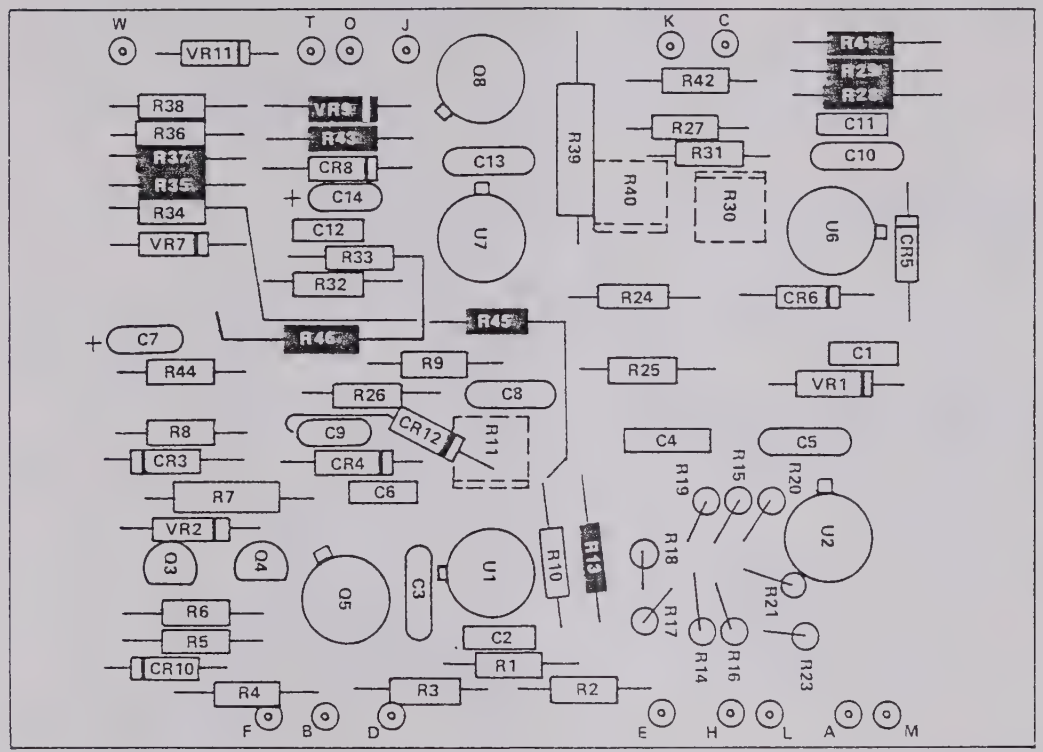


Figure 4-15. A1 Board Calibration Component Location

11. Install the Model 9202 Extender in the mainframe.

12. Mount the 5018 to the 9202; support the front of the 5018 with non-conductive material.

13. Adjust the mainframe F1—START control for 18 GHz and the F2—STOP control for 26.5 GHz.

14. Select Wide F1—F2 Sweep mode.

15. Select Manual Scan mode.

16. Rotate the VERNIER control fully ccw to 0.0.

17. Turn the mainframe power on and allow the equipment to warm up for ≈ 5 minutes.

18. Connect the equipment as shown in Figure 4-16.

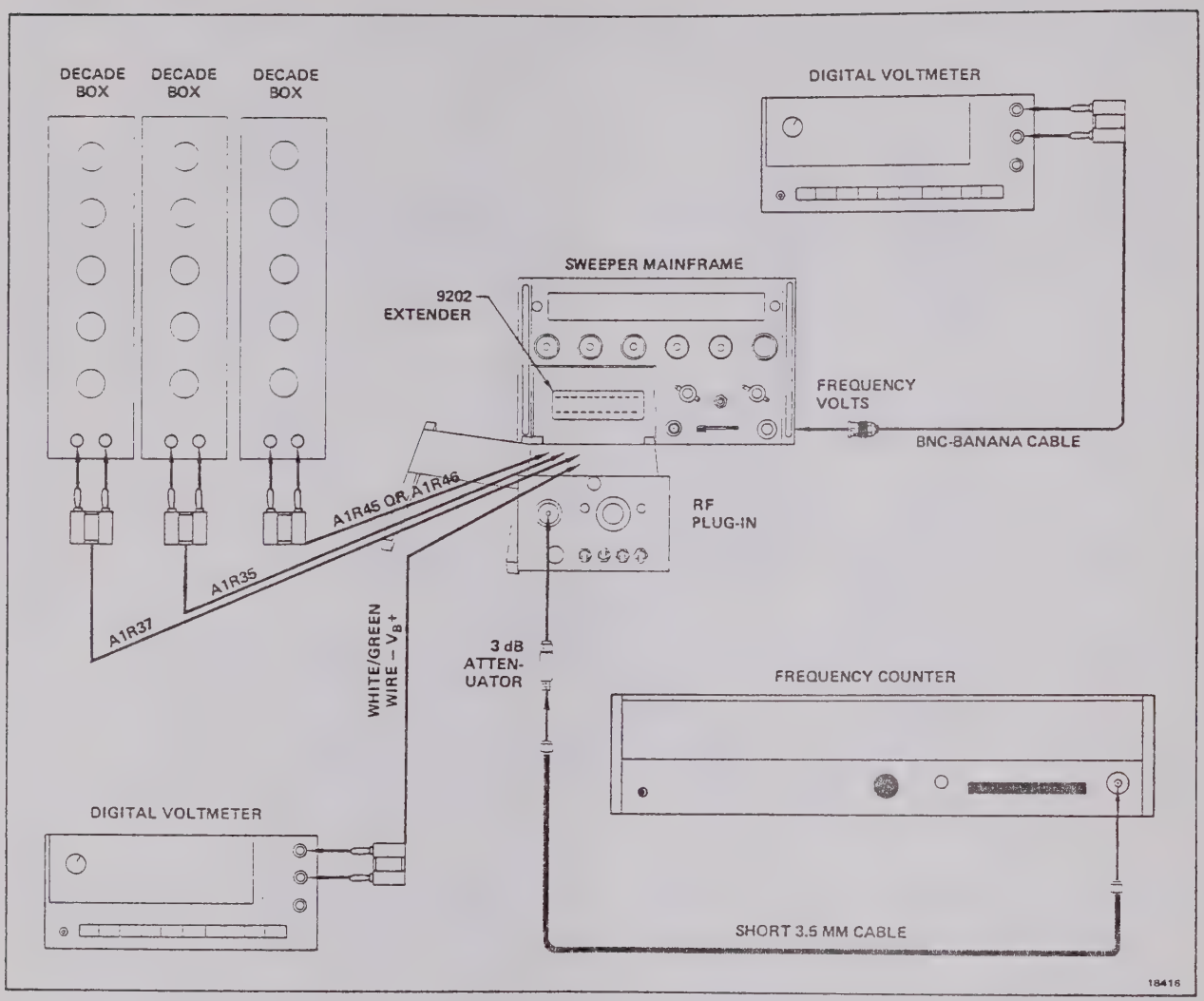


Figure 4-16. Test Setup for Oscillator Bias Voltage Setting

IMPORTANT

When the 5018 is mounted on an extender, it does not benefit from the air flow (convection cooling) within or the heat-sinking properties (conduction cooling) of the mainframe. To prevent unnecessary shortening of usable life or possible damage to the oscillator module, a method of cooling must be provided if the 5018 is operated outside the mainframe for more than ten minutes at a time.

CAUTION

RE-CHECK THE TEST SETUP AND ALL CONNECTIONS BEFORE TURNING ON MAINFRAME POWER. EXCESSIVE OPERATING VOLTAGE OR IMPROPER TEST CONNECTIONS COULD DAMAGE OSCILLATOR, PLUG-IN, OR MAINFRAME CIRCUITRY.

WARNING

WORK WITH CAUTION AROUND THE EXPOSED TERMINALS OF INTERFACE CONNECTOR P20. PIN 2 OF THIS CONNECTOR CARRIES A POTENTIALLY LETHAL VOLTAGE OF +250 Vdc.

19. Set the MANUAL SCAN control fully ccw; the voltage at the FREQUENCY VOLTS jack should be –100 ±10 mVdc. Readjust the F1–START control if necessary.

20. Select values for A1R35 and A1R37 which produce the first of the two specified nameplate or data sheet voltages for oscillator Y1 at the white/green wire.

21. Adjust the MANUAL SCAN control fully cw; the voltage at the FREQUENCY VOLTS jack should be –9.900 ±0.01 Vdc. Readjust the F2–STOP control if necessary.

22. Select a value for A1R45 which produces the second of the two specified nameplate or data sheet voltages for oscillator Y1 at the white/green wire.

23. Adjust the MANUAL SCAN control fully ccw. Continue to select values for A1R35, A1R37, and A1R45 until the following conditions are satisfied:

    a. The voltage at the white/green wire must be within ±0.07 Vdc of the first specified oscillator voltage when the voltage at the FREQUENCY VOLTS jack is –100 ±5 mVdc.

    b. The voltage at the white/green wire must be within ±0.07 Vdc of the second specified oscillator voltage when the voltage at the FREQUENCY VOLTS jack is –9.900 ±0.005 Vdc.

24. If the conditions in Step *23*, above, cannot be satisfied with selection of A1R35, A1R37, and A1R45, it will be necessary to select a new value for A1R46. This is usually required only when the lower specified oscillator voltage is appreciably different from that of the previous oscillator module.

25. Momentarily connect a shorting jumper across A1VR9; remove the short circuit and verify the V_b is < 1 Vdc.

26. Turn mainframe power off for ≈ 15 seconds, then turn it back on. Verify V_b is as set in Step *23*.

27. Turn off mainframe power.

28. Solder the white/green wire to the + VDC terminal of oscillator Y1.

29. Pick the standard resistor values closest to the decade box resistance settings for A1R35 and A1R37. The resistors must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%

c. Wattage rating of ¼ W

d. Temperature coefficient of ±9 PPM or less

30. Tack-solder these resistors to the A1 board.

31. Pick the standard resistor value closest to the decade box setting determined for A1R45 and tack-solder it in place.

32. If a new value for A1R46 was selected, pick the standard resistor value closest to the decade box setting and tack-solder it in place.

33. Select the mainframe's CW mode.

34. Turn mainframe power on.

35. Set the **CW** and **VERNIER** controls for a DVM reading of –0.100 ±0.001 Vdc.

36. Adjust A1R40 for a counter reading of 18,000 ±50 MHz.

37. Verify the voltage at + **VDC** is the specified value ± 0.070 Vdc.

38. Set the **CW** and **VERNIER** controls for a DVM reading of –9.900 ±0.001 Vdc.

39. Adjust A1R11 for a counter reading of 26,500 ±50 MHz.

40. Verify the voltage at + **VDC** is the specified value ± 0.070 Vdc.

NOTE

If it is not possible to adjust A1R40 and A1R11 as described, perform the calibration procedure of Paragraph 4-3.8 before proceeding with Step *41* of this procedure.

41. Repeat Steps *34* through *40*.

42. Turn off mainframe power.

43. Permanently solder the selected resistors in place.

4-3.8 Frequency Range Resistor Selection

It may be necessary to recalibrate the adjustment range of frequency-control potentiometers A1R40, A1R11, or A1R30 under any of the following circumstances:

1. Following replacement of a defective oscillator module

2. Following replacement of Q101, A1U1, A1U2, A1U6, A1Q5, or other components on circuit board A1

3. If V_b has been changed from the factory-set value

4. If the adjustment range of A1R40, A1R11, or A1R30 is found to be insufficient to allow the calibration procedures of Paragraph 4-3.5 to be performed.

4-3.8.1 INITIAL SETUP.

1. Put the 5018 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Set A1R30 to maximum ccw rotation.

3. Set A1R40 to the physical center of its adjustment range.

4. Set A1R11 to the physical center of its adjustment range.

5. Remove resistor A1R41 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

6. Remove resistor A1R43 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

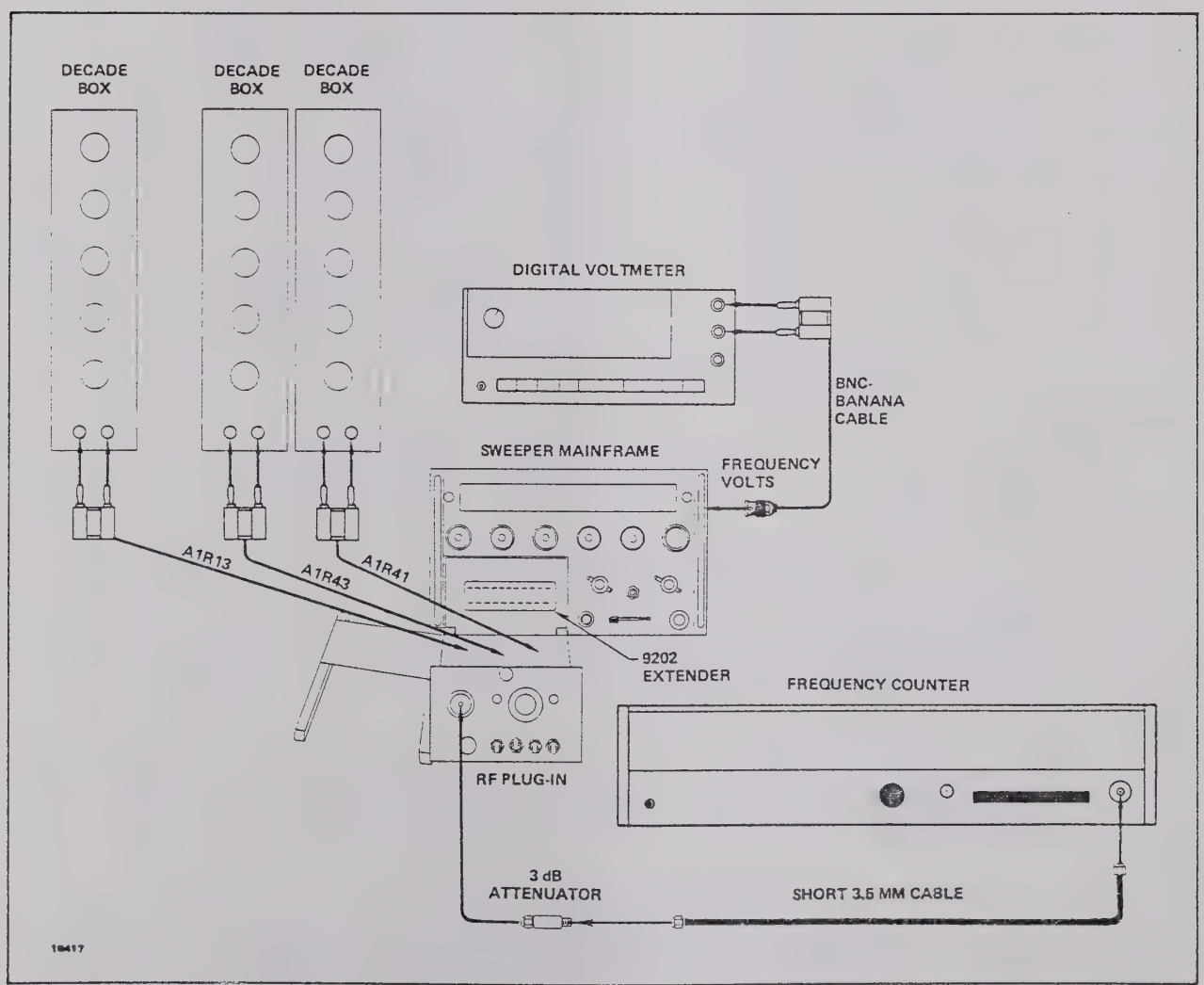


Figure 4-17. Test Setup for Frequency Range Calibration in Model 5000A Mainframe

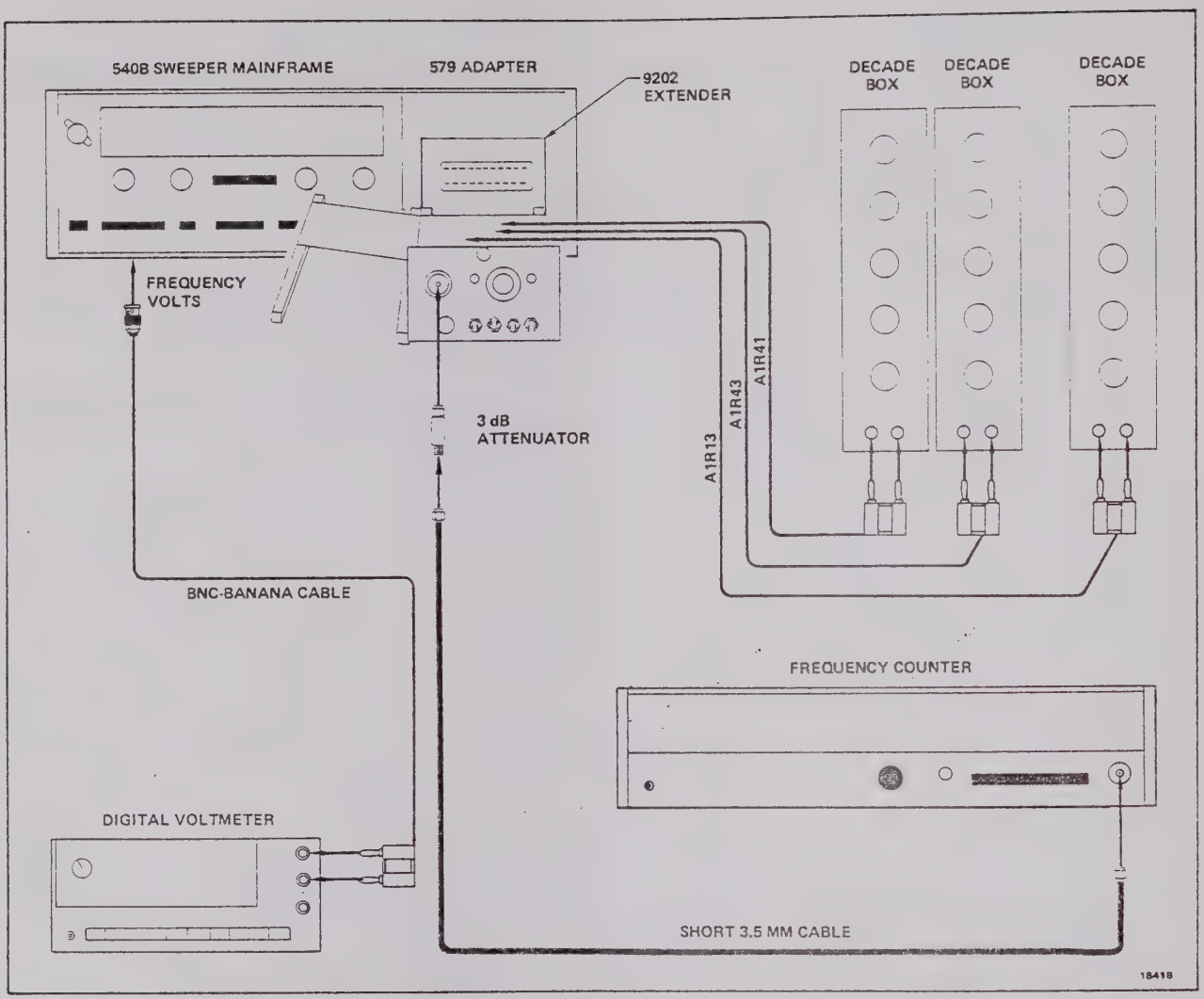


Figure 4-18. Test Setup for Frequency Range Calibration in Model 540B Mainframe/579 Adapter

7. Remove resistor A1R13 and connect a resistance decade box in its place. Set the resistance value to match that of the resistor removed.

8. Remove resistor A1R28 or A1R29.

9. Connect the test equipment as shown in Figure 4-17 (5000A mainframe) or 4-18 (540 mainframe).

10. Install the Model 9202 Extender in the mainframe.

11. Mount the 5018 to the 9202; support the front of the 5018 with non-conductive material.

12. Select the mainframe or controller's CW sweep mode.

4-3.8.2 START AND STOP FREQUENCY RANGE CALIBRATION.

1. Turn mainframe power on. Allow ≈ 5 minutes for warmup.
2. Set the **CW** control for a DVM reading of −0.100 ±0.005 Vdc.
3. Select resistance values for A1R41 and A1R43 which produce a counter reading of 18,000 ±85 MHz.
4. Rotate A1R40 throughout its range; the adjustment range should be ≈ ± 200 MHz. Select values for A1R41 and A1R43 which allow this adjustment range for A1R40 and result in an output frequency of 18,000 MHz at mid-position.
5. Set the **CW** control for a DVM reading of −9.900 ±0.005 Vdc.
6. Select a resistance value for A1R13 which produces a counter reading of 26,500 ±60 MHz.
7. Repeat Steps *2* through *6*.
8. Turn off mainframe power.
9. Pick the standard resistor value closest to the decade box resistance settings for A1R41, A1R43, and A1R13. The resistors must have the following characteristics:
   a. Metal Film construction
   b. Tolerance of ±2%
   c. Wattage rating of 1/4 W
   d. Temperature coefficient of ±9 PPM or less
10. Turn off mainframe power and remove the 5018.
11. Permanently solder the selected resistors in place.

4-3.8.3 TUNING CURRENT LIMIT RANGE CALIBRATION IN 5000A MAINFRAMES.

1. Set A1R30 to the physical center of its adjustment range.
2. If it has not already been done, remove resistors A1R28 and A1R29. Connect two resistance decade boxes together in parallel and wire the combination in place of A1R28.
3. Set both decade boxes to 1 MΩ.
4. Remove printed circuit board assembly A3 Operational Amplifier from its mating connector in the mainframe.
5. Connect the test equipment as shown in Figure 4-19.
6. Adjust the output of the power supply to zero, then connect the output cable of the power supply to the input terminals of the digital voltmeter. Be sure to connect the + output of the power supply to the DVM − terminal and the power supply − output to the DVM + terminal.

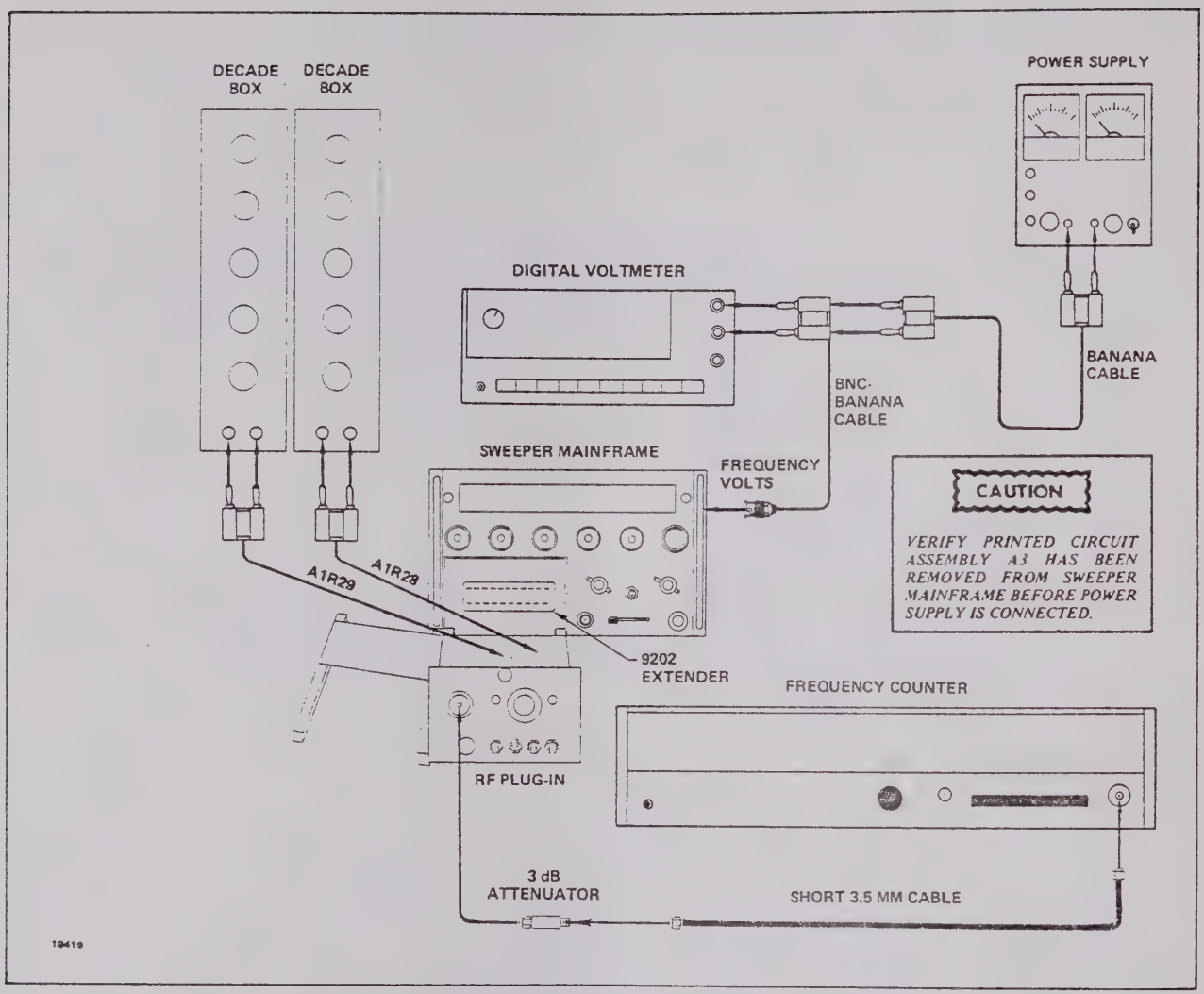


Figure 4-19. Test Setup for Tuning Current Limit Range Calibration in 5000A Mainframe

7. Press the PUSH ON-OFF switch to turn on mainframe power; allow the mainframe and 5018 to warm up for about 5 minutes.

8. Adjust the power supply voltage for a DVM reading of –10.50 ±0.01 Vdc.

9. Decrease the test resistance values until the counter reading jumps to a frequency between 26.55 and 26.65 GHz.

10. Reduce the power supply voltage to –9.9 Vdc; the counter will read 26.5 GHz.

11. Slowly increase the power supply output to a maximum of –11.0 Vdc. Select resistance values for A1R28 and/or A1R29 so that the output frequency of the 5018 is held at 26.6 GHz as the dc output of the power supply reaches –10.11 Vdc.

12. Turn off mainframe power and remove the 5018.

13. Turn off the power supply and remove its output leads from the DVM.

14. Pick the standard resistor value(s) closest to the decade box resistance settings for A1R28 and A1R29. The resistor(s) must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%.

    c. Wattage rating of ¼ W

    d. Temperature coefficient of ±9 PPM or less

15. Permanently solder the selected resistor(s) in place.

16. Re-install printed circuit assembly A3 in the mainframe.

17. Calibrate the 5018 frequency controls in accordance with Paragraph 4-3.5.

4-3.8.4 TUNING CURRENT LIMIT RANGE CALIBRATION IN 540 AND 540B MAINFRAMES/ 579 ADAPTER.

1. Set A1R30 to the physical center of its adjustment range.

2. Remove resistors A1R28 and A1R29. Connect two resistance decade boxes together in parallel and wire the combination in place of A1R28.

3. Set both decade boxes to 1 MΩ.

4. Connect the test equipment as shown in Figure 4-20.

5. Press the POWER switch to turn on mainframe power; allow the mainframe and 5018 to warm up for about 5 minutes.

6. Adjust the power supply voltage for a DVM reading of –10.50 ±0.01 Vdc.

7. Depress and latch the EXT TUNE pushbutton.

8. Decrease the test resistance values until the counter reading jumps to a frequency between 26.55 and 26.65 GHz.

9. Reduce the power supply voltage to –9.9 Vdc; the counter will read 26.5 GHz.

10. Slowly increase the power supply output to a maximum of –11.0 Vdc. Select resistance values for A1R28 and/or A1R29 so that the output frequency of the 5018 is held at 26.6 GHz as the dc output of the power supply reaches –10.11 Vdc.

11. Turn off mainframe power and remove the 5018.

12. Turn off the power supply.

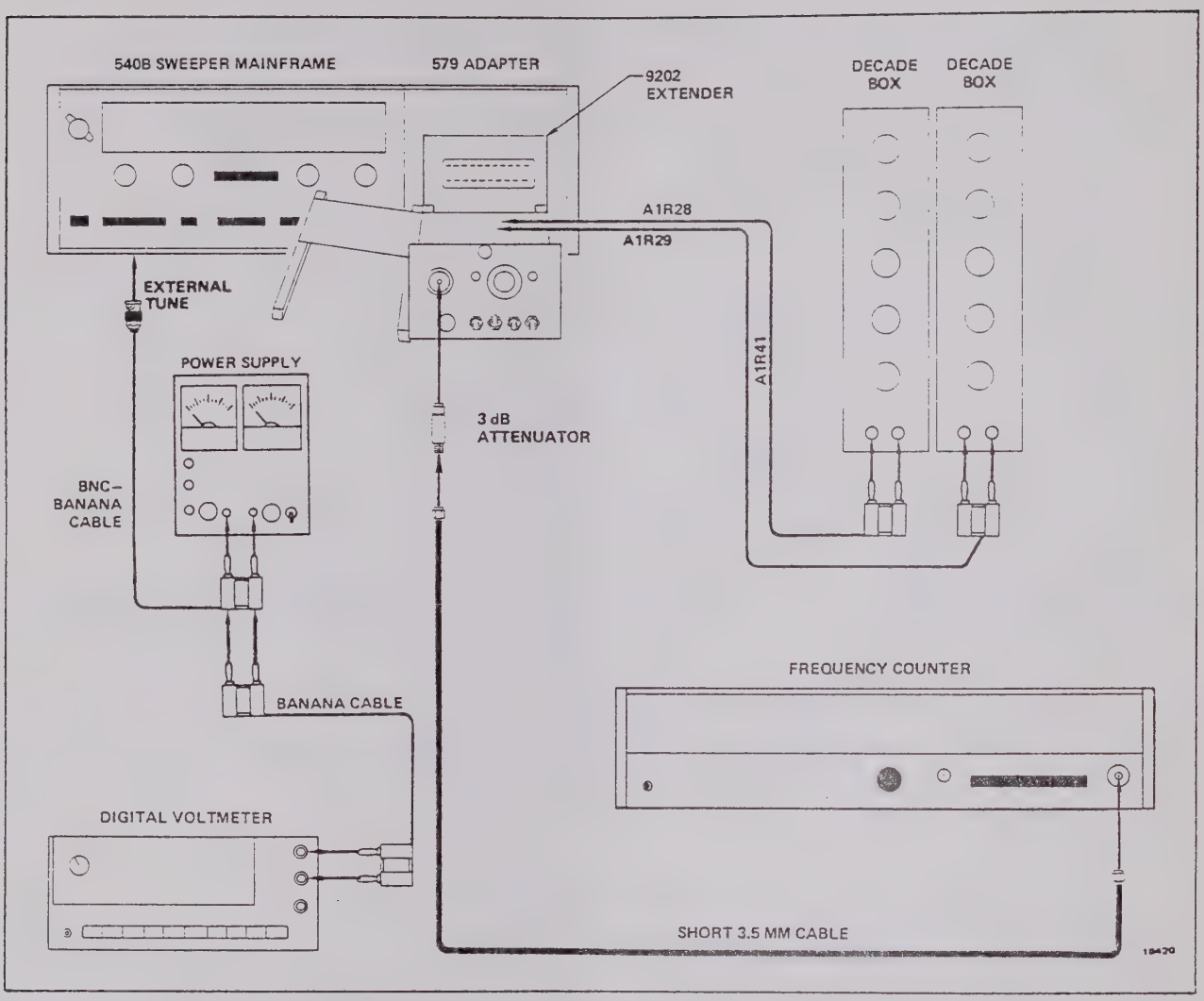


Figure 4-20. Test Setup for Tuning Current Limit Range Calibration in Model 540 or 540B Mainframe/579 Adapter

13. Pick the standard resistor value(s) closest to the decade box resistance settings for A1R28 and/or A1R29. The resistor(s) must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%

    c. Wattage rating of ¼ W

    d. Temperature coefficient of ±9 PPM or less

14. Permanently solder the selected resistor(s) in place.

15. Calibrate the 5018 frequency controls in accordance with Paragraph 4-3.5.

4-3.9 Leveling Loop Calibration

It may be necessary to recalibrate the amplitude leveling loop by installation of fixed-value components under any of the following circumstances:

1. Following replacement of a defective oscillator module
2. Following replacement of a defective modulator assembly
3. Following replacement of A2U4, A2Q5, or other components on circuit board A2
4. If the RF LEVEL control markings are found to be incorrect in leveled mode when a matched –10 mV/mW external leveler is used
5. If the RF output of the 5018 contains spurious oscillations in leveled mode only (refer to Paragraph 4-3.9.2).

4-3.9.1 AMPLITUDE CALIBRATION.

1. Put the 5018 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).
2. Remove resistors A2R25 and A2R26 and connect separate resistance decade boxes in their places. Set both decade boxes to 150 kΩ.
3. Remove resistor A2R14 and connect a resistance decade box in its place. Set the decade box to 1 MΩ.
4. Install the Model 9202 Extender in the mainframe.
5. Mount the 5018 to the 9202; support the front of the 5018 with non-conductive material.
6. Turn on mainframe power.
7. Select the mainframe or controller's wide F1—F2 sweep mode.
8. Select the fast sweep mode, 0.01 seconds.
9. Set the mainframe F1—START control to 18 GHz and the F2—STOP control to 26.5 GHz.
10. Connect the equipment as shown in Figure 4-21; do not connect the short cable to the LEVELER EXT DET jack yet.
11. Connect the + lead of the DVM to TP12 (Figure 4-22).
12. Connect the – DVM lead to chassis ground.
13. Set and calibrate the oscilloscope controls to accept the 0 to 10 V sweep ramp output of the mainframe for horizontal deflection.
14. Set the 5018 1 KHZ, MARKERS, and RETRACE switches to OFF.

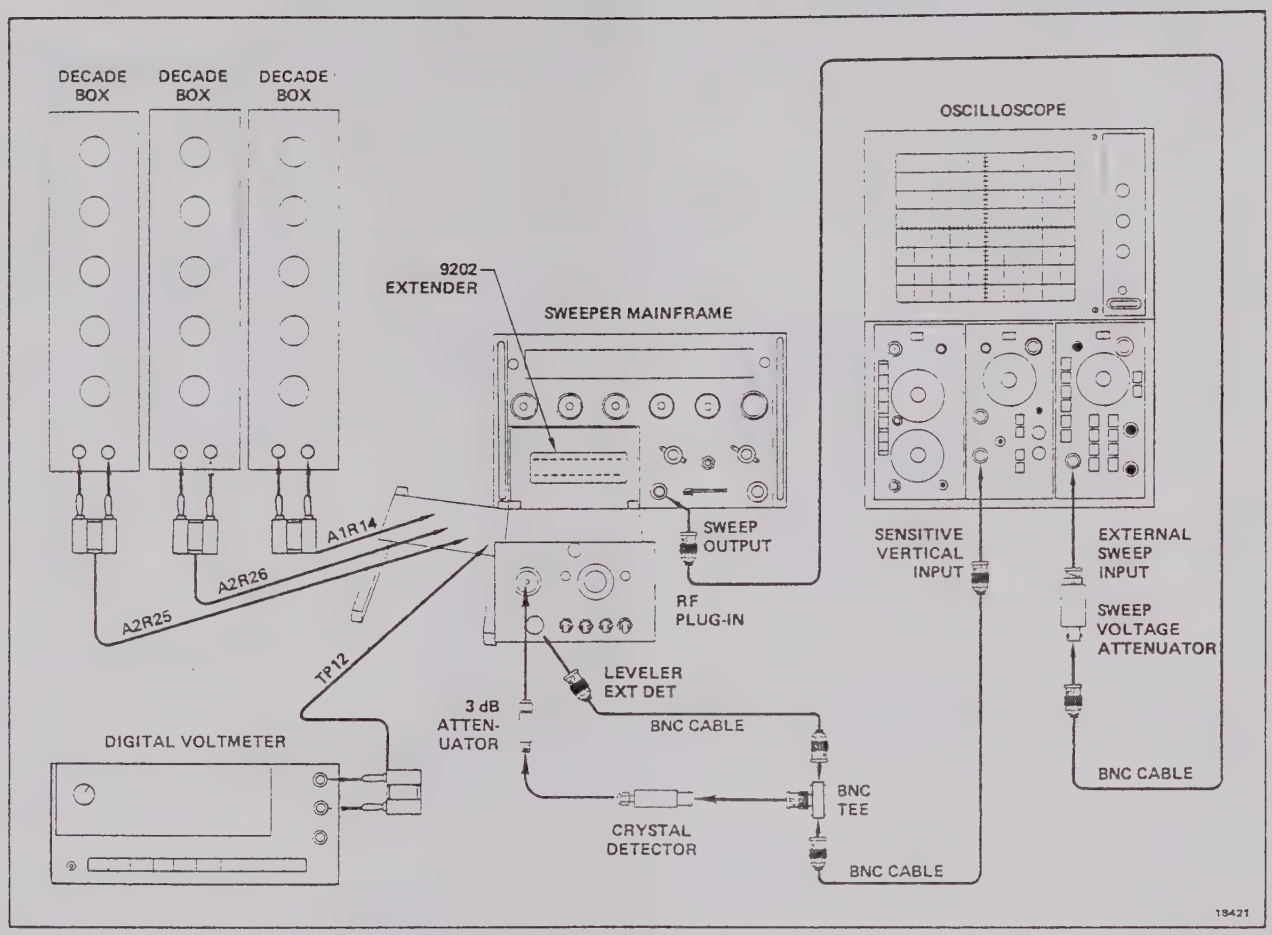


Figure 4-21. Test Setup for Leveling Loop Amplitude Calibration

15. Set the 5018 LEVELER switch to EXT.

16. Set the oscilloscope vertical channel preamplifier for 1 mV/Division. Establish a ground reference line on the oscilloscope trace.

17. Adjust the RF LEVEL control for a DVM reading of +30 ±5 mVdc.

18. If the dial is not at the "0" marking, loosen the two Allen-head set screws securing the knob to the shaft of the RF LEVEL potentiometer and reposition it.

19. Connect the short BNC cable from the tee adapter at the output of the crystal detector to the LEVELER EXT DET jack (see Figure 4-21).

20. Select resistor values for A1R25 and A2R26 which yield an output level of 0.0 mV on the oscilloscope.

21. Check the ground reference level on the oscilloscope and readjust the "position" control if necessary, then repeat Step *20*.

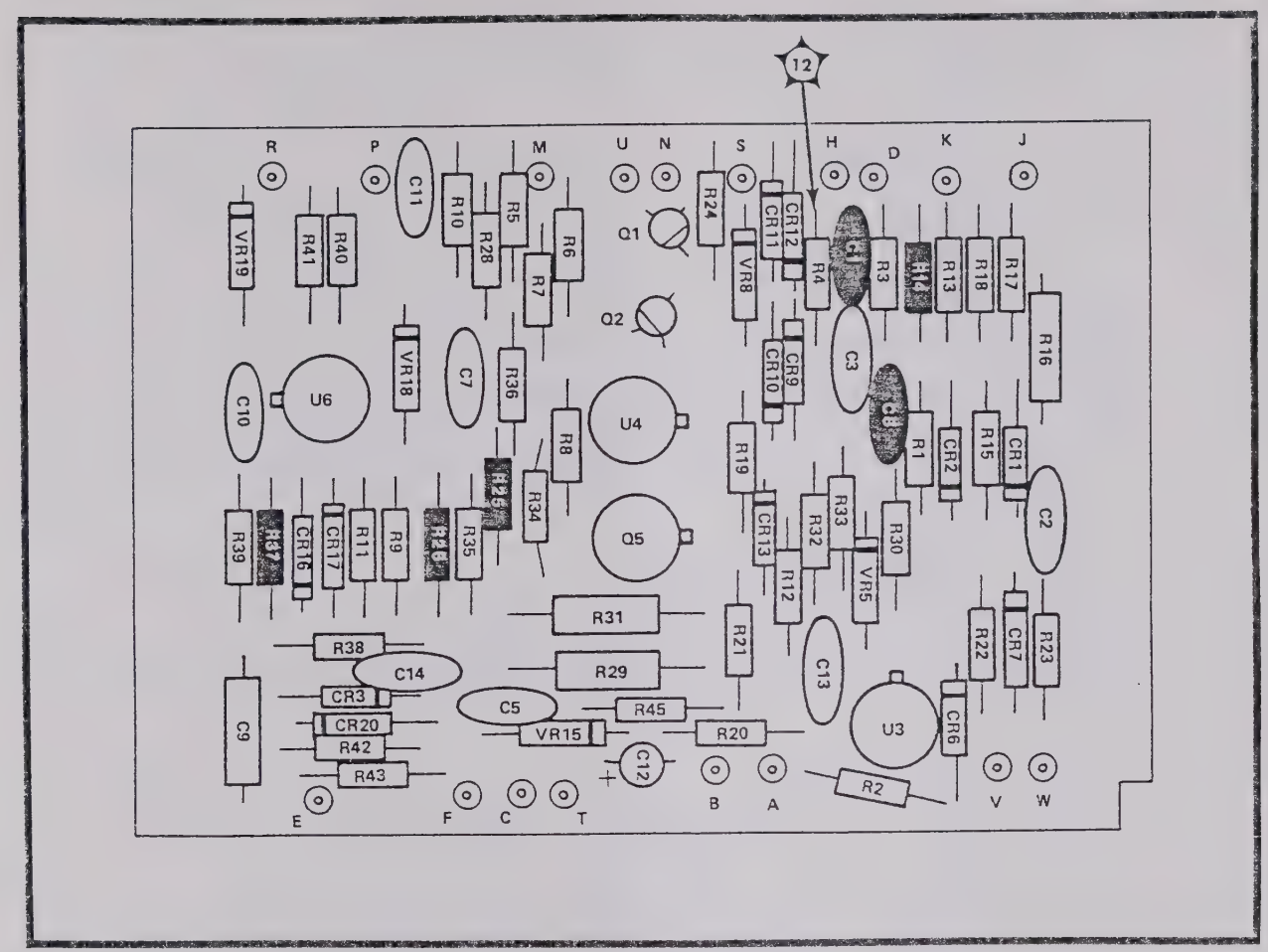


Figure 4-22. A2 Board Calibration Component Location

22. Rotate the RF LEVEL control so the dial is at 1.

23. Change the oscilloscope vertical channel sensitivity to 20 mV/Division.

24. Select a resistor value for A2R14 which causes the oscilloscope trace to deflect 50 ±5 mV.

NOTE

If the crystal detector is not flat over the 18 to 26.5 GHz range, the oscilloscope trace may exhibit a slope. If this occurs, set the F2–STOP control to 19 GHz and repeat Steps *20* through *24*.

25. Set the RF LEVEL control to 0, then repeat Steps *20* through *24*.

26. Turn off mainframe power and remove the 5018.

27. Pick the standard resistor values closest to the decade box settings for A2R14, A2R25, and A2R26. The resistors must have the following characteristics:

    a. Metal film construction

    b. Tolerance of ±2%

    c. Wattage rating of ¼ W

    d. Temperature coefficient of ±9 PPM or less

28. Permanently solder the selected resistors in place.

4-3.9.2 LEVELING LOOP TIME CONSTANT AND STABILITY CALIBRATION.

1. Put the 5018 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Remove capacitors A2C8 and A2C1.

3. Install the Model 9202 Extender in the mainframe.

4. Mount the 5018 to the 9202; support the front of the 5018 with non-conductive material.

5. Turn on mainframe power.

6. Select the mainframe or controller's wide F1—F2 sweep mode.

7. Select the fast sweep mode, 0.01 seconds.

8. Set the mainframe **F1—START** control to 18 GHz and the **F2—STOP** control to 26.5 GHz.

9. Connect the equipment as shown in Figure 4-23; connect the short BNC cable to the **LEVELER EXT DET** jack now.

10. Set the oscilloscope vertical channel sensitivity to 20 mV/Division (this may be changed later for convenience).

11. Set the oscilloscope horizontal channel controls to accept the 0 to 10 V sweep ramp output of the mainframe for horizontal deflection.

12. Adjust the 5018 **RF LEVEL** control to the setting which produces the maximum amount of oscillation on the displayed trace.

13. Select the minimum capacitance value for A2C8 which stops the oscillation; the suggested range is 15 to 68 pF. The selected capacitor should have the following characteristics:

    a. Dipped silver-mica construction

    b. Tolerance of ±5%

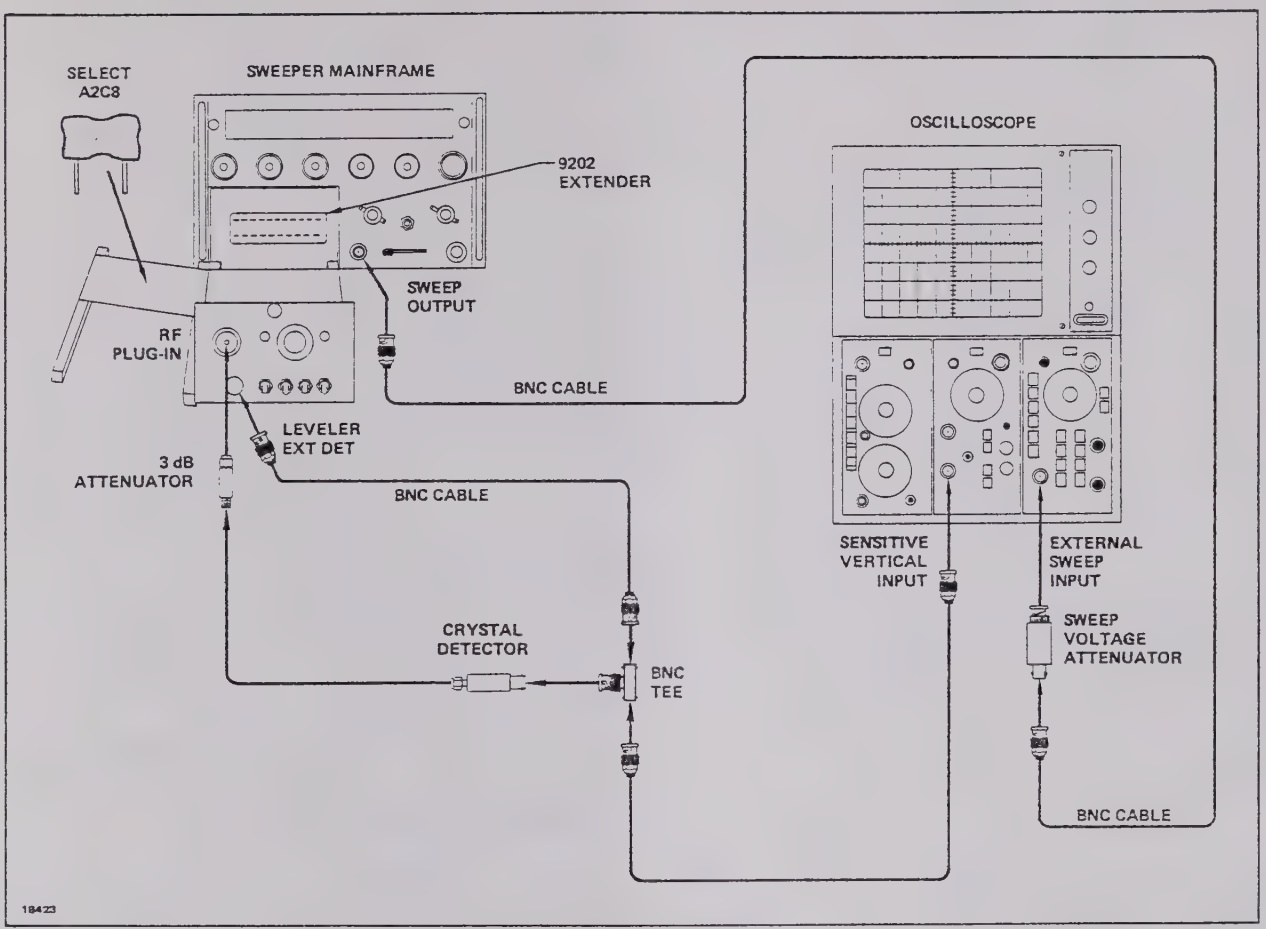


Figure 4-23. Test Setup for Leveling Loop Stability Calibration

c. Voltage rating of 500 Vdc

d. Lead spacing 0.234 in. (5,94 mm)

14. Turn off mainframe power and temporarily solder the selected capacitor for A2C8 in place.

15. Connect the test equipment as shown in Figure 4-24, with the BNC cable connecting the rear-panel **1 KHZ** jack of the mainframe to the "external trigger" input of the oscilloscope delaying time base.

16. Turn on mainframe power.

17. Set the mainframe **MODE** switch to **CW**.

18. Increase the setting of the **RF LEVEL** control to **1**.

19. Adjust the oscilloscope controls as necessary to display the trailing edge of the detected 1 kHz square wave.

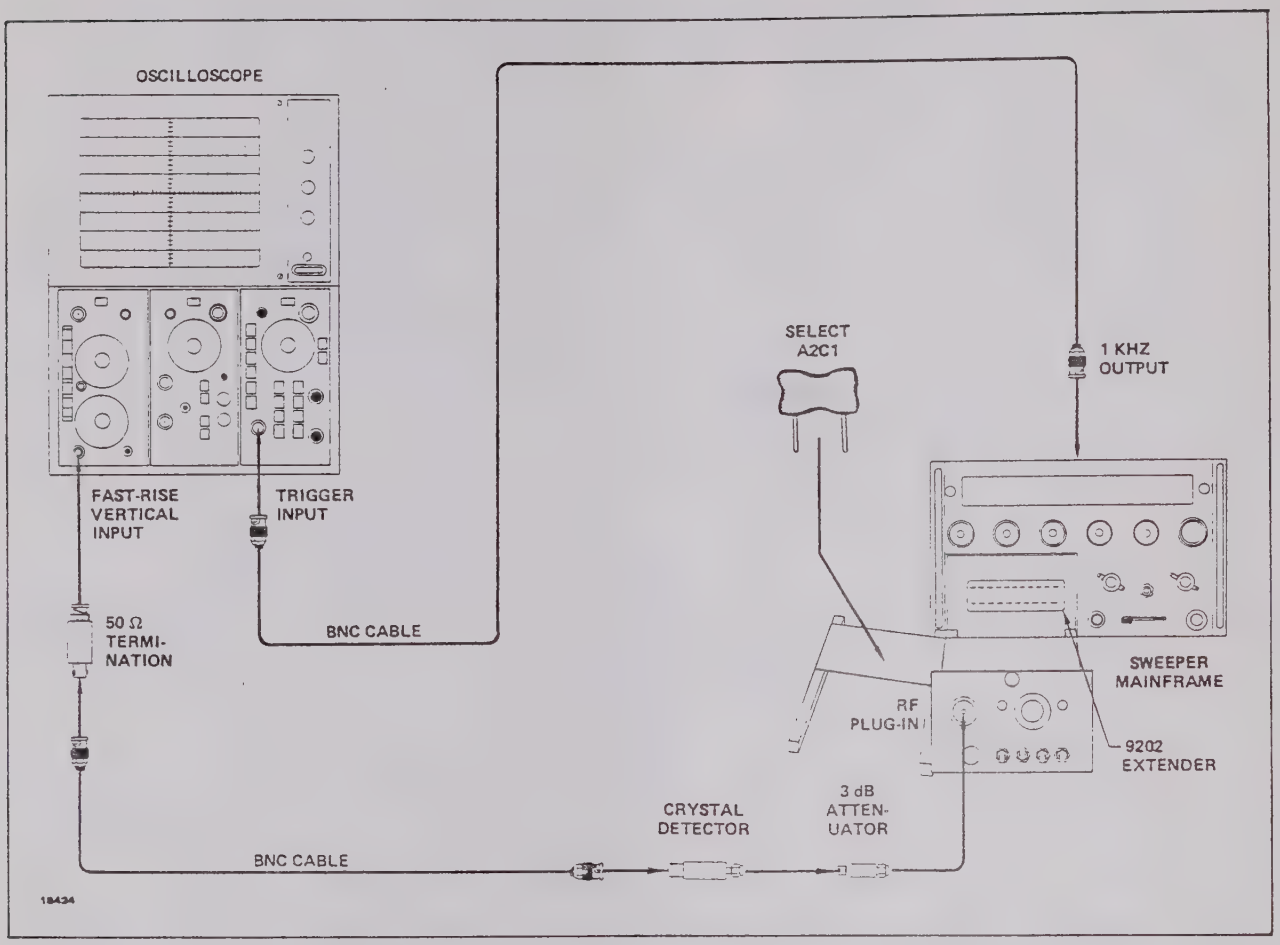


Figure 4-24. Test Setup for Leveling Loop Response Calibration

20. Select the minimum capacitance value for A2C1 which eliminates ringing and overshoot from the display (refer to Figure 4-25). Too much capacitance will slow the response time of the leveling loop and cause undershoot. The selected capacitor should have the following characteristics:

    a. Dipped silver-mica construction

    b. Tolerance of ±5%

    c. Voltage rating of 500 Vdc

    d. Lead spacing 0.234 in. (5.94 mm)

21. Turn off mainframe power and temporarily solder the selected capacitor for A2C1 in place.

22. Turn on mainframe power and measure the rise and fall-times of the square wave. If either exceeds 10 μs, select a new lower value for A2C8 and/or A2C1.

23. Turn off mainframe power and solder the selected capacitors permanently in place.

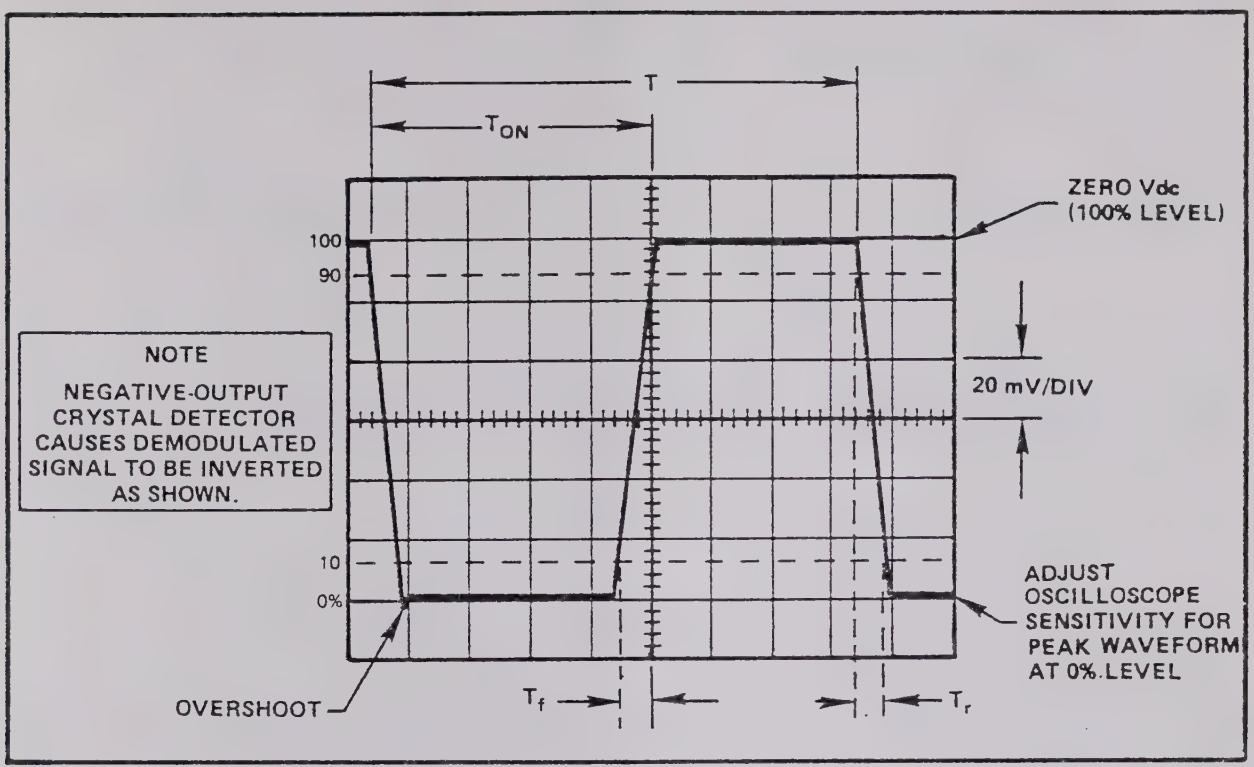


Figure 4-25. Demodulated Square Wave Characteristics

4-3.10 1 kHz Square Wave Symmetry

1. Put the 5018 in the *service/select-by-test calibration* configuration (refer to Paragraph 4-3.3.2).

2. Remove resistor A2R37 and connect a resistance decade box in its place. Set the resistance value to 9100 Ω.

3. Install the Model 9202 Extender in the mainframe.

4. Mount the 5018 to the 9202; support the front of the 5018 with non-conductive material.

5. Connect the test equipment as shown in Figure 4-26, with the BNC cable connecting the rear-panel **1 KHZ** jack of the mainframe to the "external trigger" input of the oscilloscope delaying time base.

6. Turn on mainframe power.

7. Set the mainframe **MODE** switch to **CW**.

8. Increase the setting of the **RF LEVEL** control to **1**.

9. Adjust the oscilloscope controls as necessary to display the detected 1 kHz square wave.

10. Select a resistance value for A2R37 which results in minimum symmetry error in the waveform (refer to Figure 4-25). Use the formula:

$$D = \frac{T_{on} - 0.5\,T}{0.5\,T} \times 100$$

Where

D is the symmetry error

T is the period of one complete square wave cycle

T_{on} is the period of the "on" half of the cycle (negative-going when a negative-output crystal detector is used)

11. The maximum allowable value of "D" is 5.

12. Turn off mainframe power.

13. Pick the standard resistor closest to the decade box setting.

14. Permanently solder the selected resistor in place.

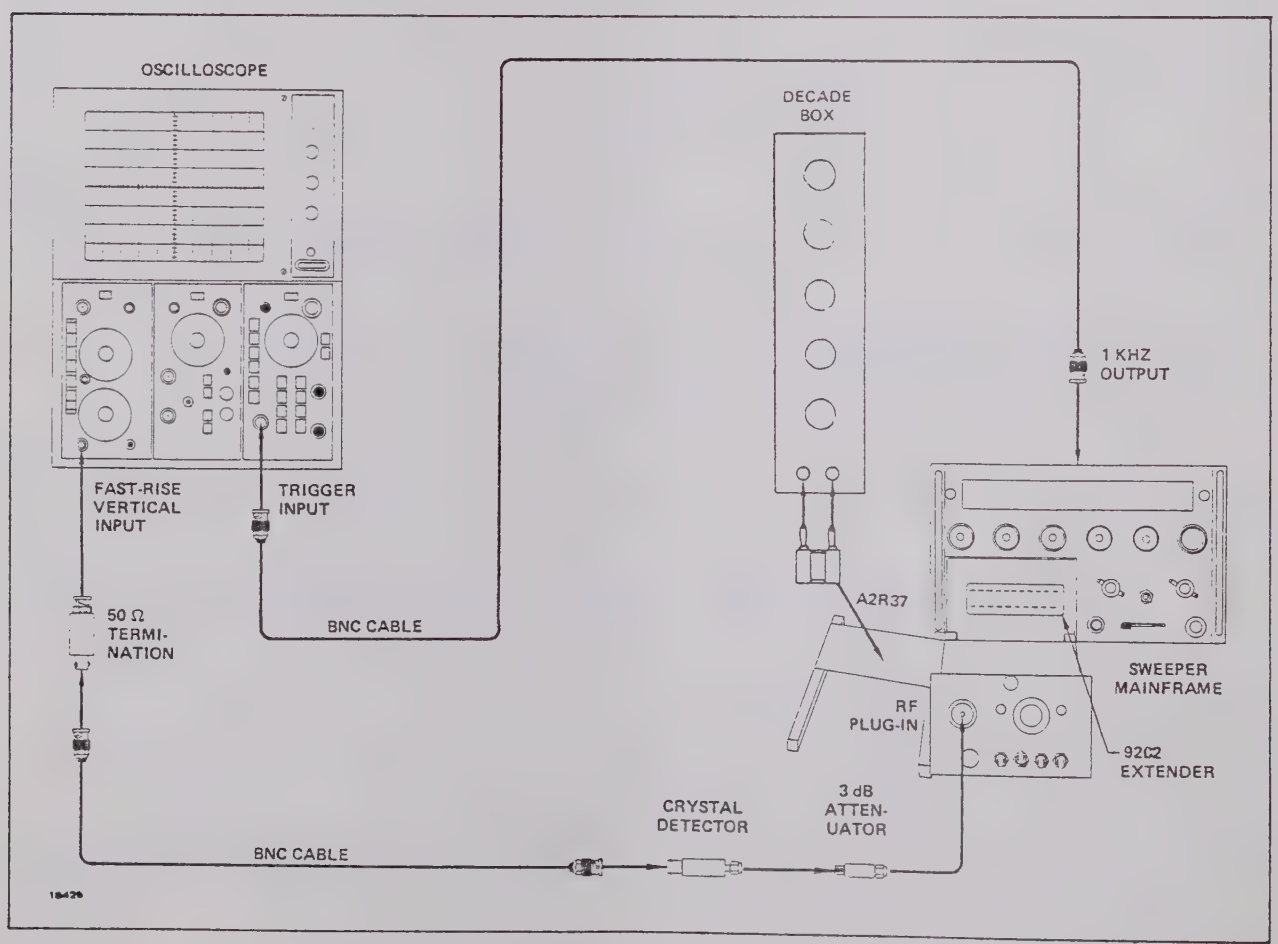


Figure 4-26. Test Setup for 1 kHz Symmetry Calibration

SECTION V

MAINTENANCE

5-1. GENERAL

This section contains instructions for routine servicing and cleaning of the 5018 and for the isolation and repair of malfunctioning circuits and components.

5-2. ROUTINE MAINTENANCE

In normal laboratory environments, the 5018 requires only brief annual service. Ideally, the plug-in and the mainframe in which it is used should be serviced together. If the mainframe has an air filter, inspect it regularly and clean it whenever necessary. The plug-in should also be cleaned at regular intervals:

1. Turn off mainframe power.

2. Loosen the plug-in locking screw and remove the plug-in from the mainframe.

3. Inspect the unit carefully for loose screws, nuts, etc.; tighten any hardware requiring it.

4. Clean all dust and other foreign substances from the plug-in. Use a soft brush and low-pressure dry air. In severe cases, a zero-residue cleaner and degreaser such as trichlorotriflouroethane may be used. This compound is available in an aerosol container as "FD Contact Cleaner" (1638-16S) from Tech-Spray, Amarillo, Texas, or under Federal Stock Number 6850-00105-3084, Cleaning Compound, Solvent. The solvent is also available in liquid form as Genesolv® D from Allied Chemical Corporation.

5. This solvent or isopropyl alcohol may be used to clean residue or metal chips from the inside of the RF OUT connector.

6. Clean the dial scale with a clean, soft rag and a mild detergent solution.

CAUTION

DO NOT USE ALCOHOL OR SOLVENT.

5-3. CALIBRATION

The Performance Checks of Paragraph 4-2 and the Routine Frequency Calibration procedure of Paragraph 4-3.3.1 should be completed annually. The referenced procedures are found in Section IV of this manual.

5-4. CORRECTIVE MAINTENANCE

5-4.1 Trouble Isolation (Figure 5-1)

5-4.1.1 TROUBLE ISOLATION PROCESS. The Performance Checks of Section IV provide the principal means of determining that electrical performance of the 5018 is within specified parameters. In the event of evident failure or malfunction, certain logical steps must be followed and decisions made to effect repair or correct a malfunction within the shortest period possible. The basic process may be summarized as follows:

1. Does a malfunction in fact exist, or is an evident malfunction the result of incorrect switch or control positioning, incorrect external input signals, or misapplication of the sweeper/plug-in system?

2. If a malfunction does exist, is the fault in the plug-in or in the mainframe?

3. If the malfunction is within the plug-in, in which circuit or circuits is it located?

4. Which components within the affected circuits have malfunctioned?

5. What caused the malfunction, and will simple replacement of faulty components solve the problem permanently?

5-4.1.2 SUPPORTING INFORMATION. Figure 5-1 is an aid to trouble isolation, to be used in conjunction with the following information:

1. The detailed circuit descriptions and block diagrams in Sections VI, VIII, and IX.

2. The schematic diagrams and board component-location drawings in Sections VIII and IX and the chassis wiring diagram in Section VII.

3. The basing diagrams of multi-lead semiconductor devices used in the plug-in, shown on the wiring diagram of the 5018 (Figure 7-2), the A1 board assembly (Figure 8-3), the A2 board assembly (Figure 9-3), or the A3 board assembly (Figure 9-4).

4. The subassembly and component location information in Figures 4-14 and 7-1.

5-4.1.3 TROUBLE ISOLATION DIAGRAMS. Figure 5-1 is one of three separate sequences and several sub-sequences used to isolate malfunctions from the system level, to the malfunctioning circuit, to the malfunctioning individual component. Figure 5-1, located at the end of this section, is organized as follows:

1. *START Sequence.* This sequence is used to direct the troubleshooter to the malfunctioning circuit area within the sweeper mainframe/plug-in system.

2. *Sequence A* is concerned with active and passive RF components.

3. *Sequence B* is the troubleshooting figure related to the frequency control circuits and tuning coil drivers.

4. *Sequence C* is concerned with the amplitude control and leveling functions.

Trouble isolation information in Figure 5-1 will guide the repair technician to malfunctioning chassis-mounted components and complete assemblies.

Trouble isolation diagrams for printed circuit assembly A1 (oscillator driver) are found in Section VIII of this manual. Trouble isolation diagrams for printed circuit assemblies A2 (leveler/AM) and A3 (power meter leveling) are in Section IX.

5-4.2 Test Equipment

The calibration test equipment listed in Table 4-4, Section IV, should be used for trouble isolation.

CAUTION

BE VERY CAREFUL WITH OSCILLOSCOPE AND VOLTMETER PROBES TO AVOID ACCIDENTALLY BRIDGING TWO POINTS OR SHORT-CIRCUITING A WIRE OR COMPONENT LEAD TO GROUND. LACK OF ADEQUATE CARE WITH SEMICONDUCTOR AND INTEGRATED CIRCUITS CAN TURN RELATIVELY MINOR PROBLEMS INTO COSTLY EXPERIENCES.

Systron-Donner Extender Model 9202 and Plug-in Inverter Model 9203 are required for trouble isolation and repair of the plug-in.

5-4.3 Printed Circuit Board Repair

Repair of the plug-in comprises location and replacement of defective components. To avoid damage to the printed circuit boards and precision components, solder or remove components only with a low-power (25 to 50 W, 500 to 650°) soldering iron. Do not use soldering guns or large irons. Use only 60-40 or 63-37 rosin core solder. To remove the integrated circuit operational amplifiers or other multi-lead devices, use a special iron tip that unsolders all leads at the same time (available from Ungar and other manufacturers). Remove excess solder from circuit board holes with a vacuum de-soldering device (available from Edsyn, Ungar, Wen, Viking, etc.).

5-4.5 Component Removal and Re-assembly

Refer to Paragraph 4-3.3.2, Section IV, for instructions to place the plug-in in its *service and select-by-test calibration* configuration. For disassembly to a greater depth, use the *Illustrated Parts Breakdown* — Figure 7-1 of Section VII — as a guide to disassembly and reassembly sequences.

Use the following method to assure reliable mating and low VSWR when reassembling the 3.5-millimeter connector pairs used inside the 5018:

1. Remove metal particles or other foreign material from both connectors using a Q-Tip® moistened with isopropyl alcohol.

IMPORTANT

Do not use aromatic or chlorinated hydrocarbons, esters, ethers, terpenes, higher alcohols, ketones, or ether-alcohols such as benzene, toluene, turpentine, dioxane, gasoline, cellosolve, acetone, or carbon tetrachloride. Keep exposure of the connector parts to the alcohol and its vapors as brief as possible.

2. Remove all alcohol from the connectors and allow them to dry thoroughly.

3. Mate the connectors straight on and tighten with hand pressure only. Disconnect and inspect the pair if unusual resistance is felt as the connectors are being mated; the center conductor may be misaligned.

4. Tighten the connector nut to 8 ±1 inch-pounds with a 5/16 inch torque wrench.

5-4.6 Oscillator Module Repair and Replacement

The oscillator module is the single most expensive item in the 5018. Before ordering a replacement oscillator module, you may wish to consider the following:

1. Absence of RF output power is not necessarily indicative of a malfunctioning oscillator. A malfunction in the operating voltage regulating circuitry could reduce or increase the operating voltage beyond the narrow range over which the oscillator is designed to operate.

2. An oscillator to which no tuning current is applied may have no RF output; the tuning components within the oscillator will not be magnetically saturated.

3. Printed circuit oscillator driver assembly A1 contains over-voltage, over-current, and reverse polarity protection for the oscillator V_b and V_t drives. In addition, the oscillator modules themselves have over-voltage Zener diodes. In the event of malfunction, one or more of these protective devices may be destroyed. It is imperative that the following components be replaced in this event, even though their absence will not affect normal operation:

   a. Zener diode A1VR9

   b. SCR A1Q8

   c. Diode A2CR8

   d. Zener diode A2VR11

4. A "dead" oscillator module may be repairable at the factory level, and you may wish to consider this option. The oscillator module is not field-repairable.

5. When replacing an oscillator module, the white/green wire must not be connected until the instruction to do so is reached during performance of the *oscillator voltage setting procedure*, Paragraph 4-3.7 of Section IV.

5-5. MODIFICATIONS AND OPTIONS

5-5.1 Option M6, Wide Deviation Phase Lock

The user may modify the 5018 plug-in to this configuration whenever the wide phase lock deviation capability is desired. Refer to Table 1-1 (Section I) for applicable performance specifications, to Figure 4-15 (Section IV) for component location information, and to wiring diagram Figure 7-2 (Section VII):

1. Place the RF plug-in in the *service and select-by-test calibration* configuration described in Paragraph 4-3.3.2, Section IV.

2. Locate the gray twin-conductor shielded cable connected to the +FM and –FM terminals of the oscillator module.

3. Disconnect the black wire originating at P20-10 from the –FM terminal.

4. Disconnect the red wire originating at P20-11 and the clear shield wire from the +FM terminal.

5. Insulate the ends of the wires removed in Steps *3* and *4* and tie them into the wire harness.

6. Disconnect the black wire from P20-10.

7. Disconnect the red wire from P20-11.

8. Insulate the ends of the wires removed in Steps *6* and *7* and tie them into the wire harness.

9. Solder a 2 inch (5 cm) red wire from P20-11 to terminal L of printed circuit assembly A1.

10. Solder a 2 inch (5 cm) black wire from P20-10 to terminal H of printed circuit assembly A1.

11. Solder a short piece of bus wire between the +FM and –FM terminals of the oscillator module.

12. Re-assemble the plug-in; install new cable straps if any were removed during the modification.

13. The phase lock input will now be considerably more sensitive to electrical noise and electromagnetic radiation. It is important that the PHASE LOCK connector on the rear panel of the mainframe or adapter be kept short-circuited when not in use by removing the mating plug completely or by inserting a shorting plug. Do not leave an unterminated input cable attached to the PHASE LOCK connector.

5-5.2 Option M7, Negative Power Meter Leveling

This option is installable at factory level only.

5-5.3 Option M7A, Positive Power Meter Leveling

This option is installable at factory level only.

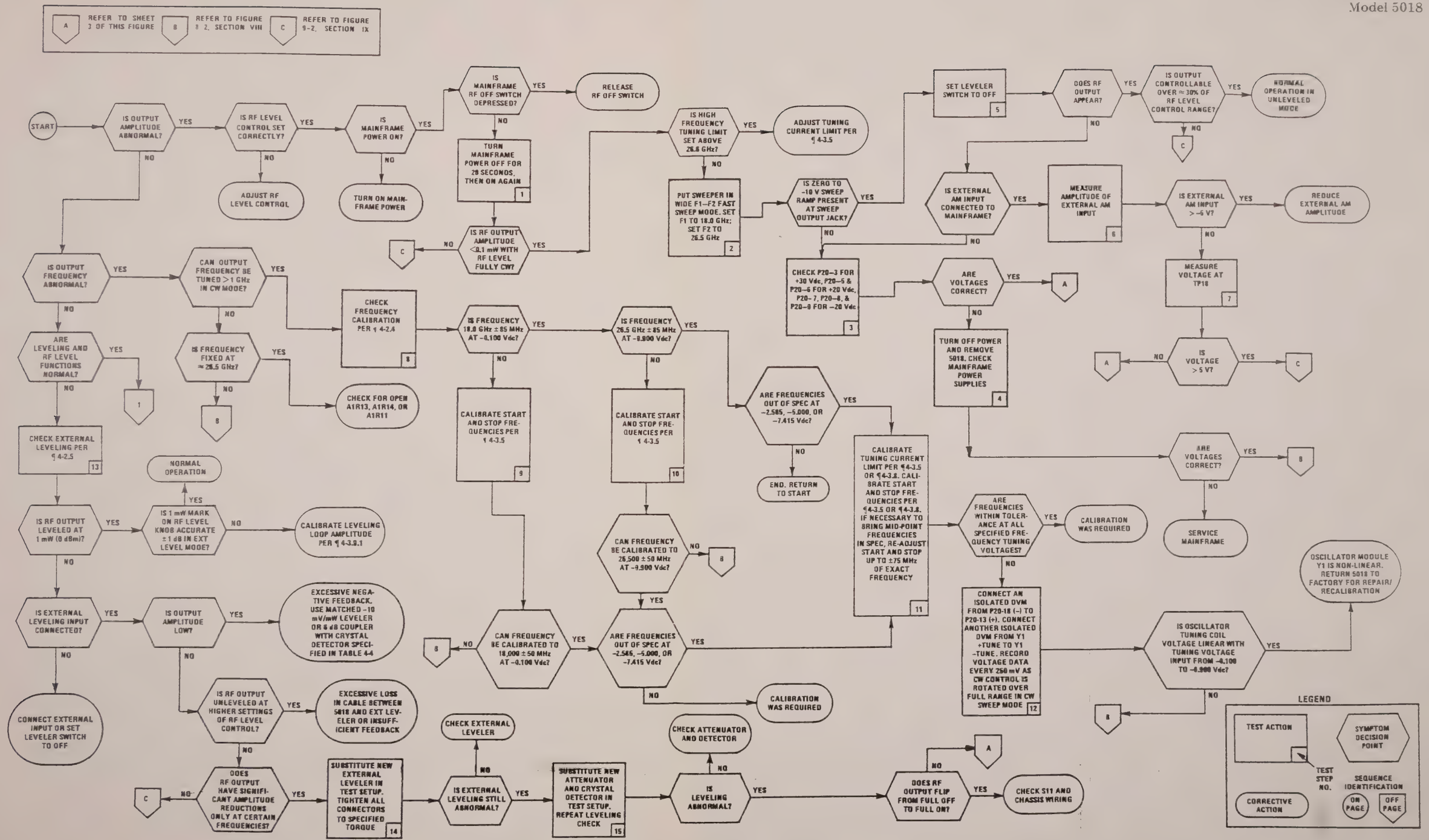

A REFER TO SHEET 3 OF THIS FIGURE
B REFER TO FIGURE 8-2, SECTION VIII
C REFER TO FIGURE 9-2, SECTION IX
START
IS OUTPUT AMPLITUDE ABNORMAL?
IS RF LEVEL CONTROL SET CORRECTLY?
ADJUST RF LEVEL CONTROL
IS MAINFRAME POWER ON?
TURN ON MAIN-FRAME POWER
IS MAINFRAME RF OFF SWITCH DEPRESSED?
RELEASE RF OFF SWITCH
TURN MAINFRAME POWER OFF FOR 20 SECONDS, THEN ON AGAIN 1
IS RF OUTPUT AMPLITUDE <0.1 mW WITH RF LEVEL FULLY CW?
IS HIGH FREQUENCY TUNING LIMIT SET ABOVE 26.6 GHz?
ADJUST TUNING CURRENT LIMIT PER ¶ 4-3.5
PUT SWEEPER IN WIDE F1–F2 FAST SWEEP MODE. SET F1 TO 18.0 GHz; SET F2 TO 26.5 GHz 2
IS ZERO TO –10 V SWEEP RAMP PRESENT AT SWEEP OUTPUT JACK?
CHECK P20–3 FOR +30 Vdc, P20–5 & P20–6 FOR +20 Vdc, P20–7, P20–8, & P20–9 FOR –20 Vdc 3
SET LEVELER SWITCH TO OFF 5
DOES RF OUTPUT APPEAR?
IS OUTPUT CONTROLLABLE OVER ≈ 30% OF RF LEVEL CONTROL RANGE?
NORMAL OPERATION IN UNLEVELED MODE
IS EXTERNAL AM INPUT CONNECTED TO MAINFRAME?
MEASURE AMPLITUDE OF EXTERNAL AM INPUT 6
IS EXTERNAL AM INPUT >–5 V?
REDUCE EXTERNAL AM AMPLITUDE
MEASURE VOLTAGE AT TP18 7
IS VOLTAGE >5 V?
ARE VOLTAGES CORRECT?
TURN OFF POWER AND REMOVE 5018, CHECK MAINFRAME POWER SUPPLIES 4
IS OUTPUT FREQUENCY ABNORMAL?
CAN OUTPUT FREQUENCY BE TUNED > 1 GHz IN CW MODE?
CHECK FREQUENCY CALIBRATION PER ¶ 4-2.4 8
IS FREQUENCY FIXED AT ≈ 26.5 GHz?
CHECK FOR OPEN A1R13, A1R14, OR A1R11
ARE LEVELING AND RF LEVEL FUNCTIONS NORMAL?
CHECK EXTERNAL LEVELING PER ¶ 4-2.5 13
IS FREQUENCY 18.0 GHz ± 85 MHz AT –0.100 Vdc?
CALIBRATE START AND STOP FREQUENCIES PER ¶ 4-3.5 9
IS FREQUENCY 26.5 GHz ± 85 MHz AT –9.900 Vdc?
CALIBRATE START AND STOP FREQUENCIES PER ¶ 4-3.5 10
ARE FREQUENCIES OUT OF SPEC AT –2.585, –5.000, OR –7.415 Vdc?
END. RETURN TO START
CALIBRATE TUNING CURRENT LIMIT PER ¶4-3.5 OR ¶4-3.8. CALIBRATE START AND STOP FREQUENCIES PER ¶4-3.5 OR ¶4-3.8. IF NECESSARY TO BRING MID-POINT FREQUENCIES IN SPEC, RE-ADJUST START AND STOP UP TO ±75 MHz OF EXACT FREQUENCY 11
ARE FREQUENCIES WITHIN TOLERANCE AT ALL SPECIFIED FREQUENCY TUNING VOLTAGES?
CALIBRATION WAS REQUIRED
ARE VOLTAGES CORRECT?
SERVICE MAINFRAME
CONNECT AN ISOLATED DVM FROM P20-18 (–) TO P20-13 (+). CONNECT ANOTHER ISOLATED DVM FROM Y1 +TUNE TO Y1 –TUNE. RECORD VOLTAGE DATA EVERY 250 mV AS CW CONTROL IS ROTATED OVER FULL RANGE IN CW SWEEP MODE 12
IS OSCILLATOR TUNING COIL VOLTAGE LINEAR WITH TUNING VOLTAGE INPUT FROM –0.100 TO –9.900 Vdc?
OSCILLATOR MODULE Y1 IS NON-LINEAR. RETURN 5018 TO FACTORY FOR REPAIR/ RECALIBRATION
IS RF OUTPUT LEVELED AT 1 mW (0 dBm)?
IS 1 mW MARK ON RF LEVEL KNOB ACCURATE ±1 dB IN EXT LEVEL MODE?
NORMAL OPERATION
CALIBRATE LEVELING LOOP AMPLITUDE PER ¶ 4-3.9.1
IS EXTERNAL LEVELING INPUT CONNECTED?
IS OUTPUT AMPLITUDE LOW?
EXCESSIVE NEGATIVE FEEDBACK. USE MATCHED –10 mV/mW LEVELER OR 6 dB COUPLER WITH CRYSTAL DETECTOR SPECIFIED IN TABLE 4-4
CONNECT EXTERNAL INPUT OR SET LEVELER SWITCH TO OFF
IS RF OUTPUT UNLEVELED AT HIGHER SETTINGS OF RF LEVEL CONTROL?
EXCESSIVE LOSS IN CABLE BETWEEN 5018 AND EXT LEVELER OR INSUFFICIENT FEEDBACK
DOES RF OUTPUT HAVE SIGNIFICANT AMPLITUDE REDUCTIONS ONLY AT CERTAIN FREQUENCIES?
SUBSTITUTE NEW EXTERNAL LEVELER IN TEST SETUP. TIGHTEN ALL CONNECTORS TO SPECIFIED TORQUE 14
CHECK EXTERNAL LEVELER
IS EXTERNAL LEVELING STILL ABNORMAL?
SUBSTITUTE NEW ATTENUATOR AND CRYSTAL DETECTOR IN TEST SETUP. REPEAT LEVELING CHECK 15
CHECK ATTENUATOR AND DETECTOR
IS LEVELING ABNORMAL?
DOES RF OUTPUT FLIP FROM FULL OFF TO FULL ON?
CHECK S11 AND CHASSIS WIRING
CAN FREQUENCY BE CALIBRATED TO 26,500 ± 50 MHz AT –9.900 Vdc?
CAN FREQUENCY BE CALIBRATED TO 18,000 ± 50 MHz AT –0.100 Vdc?
ARE FREQUENCIES OUT OF SPEC AT –2.585, –5.000, OR –7.415 Vdc?
CALIBRATION WAS REQUIRED
LEGEND
TEST ACTION
SYMPTOM DECISION POINT
TEST STEP NO.
SEQUENCE IDENTIFICATION
CORRECTIVE ACTION
ON PAGE
OFF PAGE

Figure 5-1. Troubleshooting Diagram (Sheet 1)

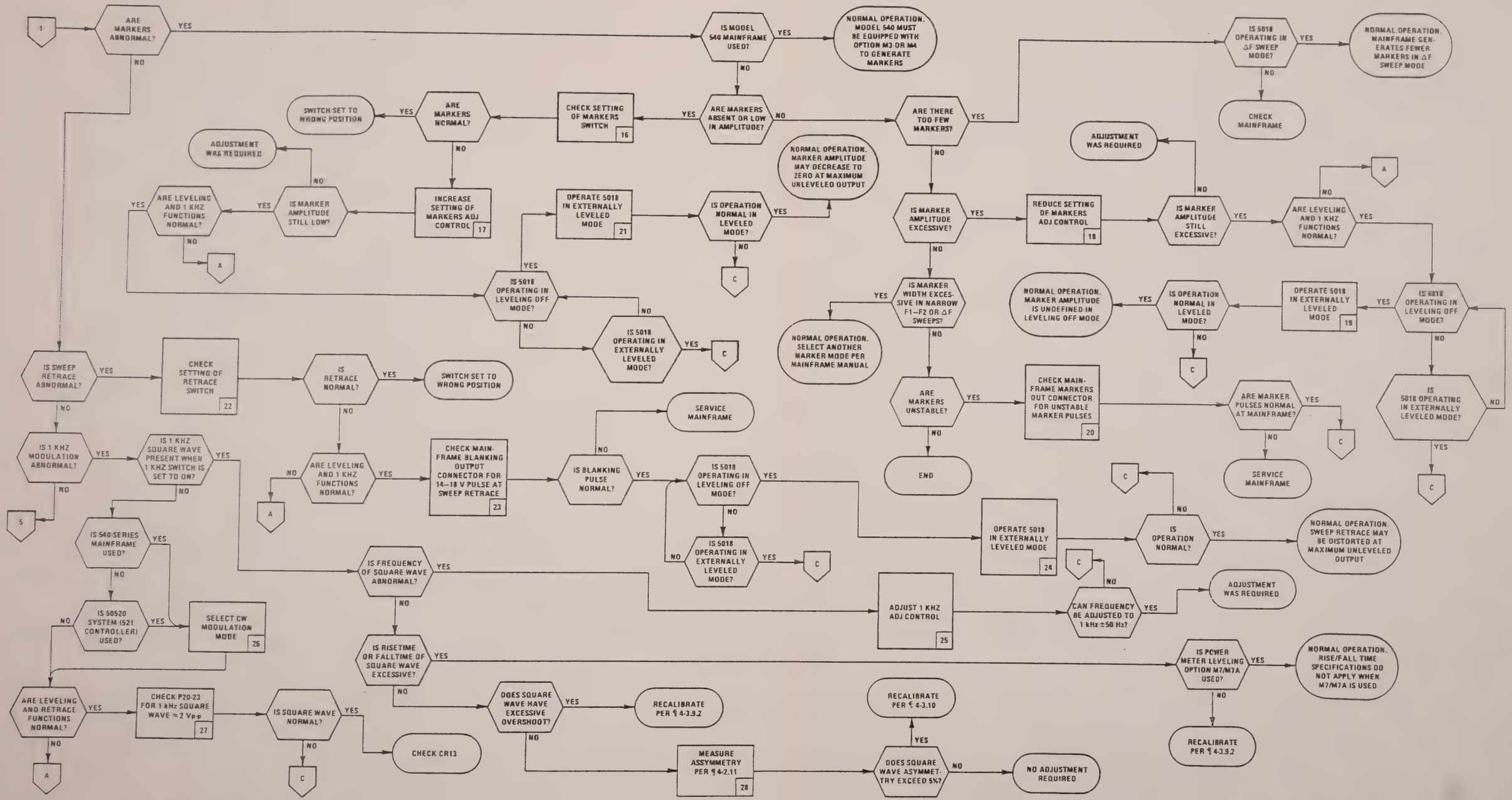

1
ARE MARKERS ABNORMAL?
YES
NO
IS MODEL 540 MAINFRAME USED?
YES
NORMAL OPERATION. MODEL 540 MUST BE EQUIPPED WITH OPTION M3 OR M4 TO GENERATE MARKERS
NO
ARE MARKERS ABSENT OR LOW IN AMPLITUDE?
YES
CHECK SETTING OF MARKERS SWITCH 16
ARE MARKERS NORMAL?
SWITCH SET TO WRONG POSITION
ADJUSTMENT WAS REQUIRED
INCREASE SETTING OF MARKERS ADJ CONTROL 17
IS MARKER AMPLITUDE STILL LOW?
ARE LEVELING AND 1 KHZ FUNCTIONS NORMAL?
A
OPERATE 5018 IN EXTERNALLY LEVELED MODE 21
IS OPERATION NORMAL IN LEVELED MODE?
NORMAL OPERATION. MARKER AMPLITUDE MAY DECREASE TO ZERO AT MAXIMUM UNLEVELED OUTPUT
C
IS 5018 OPERATING IN LEVELING OFF MODE?
IS 5018 OPERATING IN EXTERNALLY LEVELED MODE?
ARE THERE TOO FEW MARKERS?
IS 5018 OPERATING IN ΔF SWEEP MODE?
NORMAL OPERATION. MAINFRAME GENERATES FEWER MARKERS IN ΔF SWEEP MODE
CHECK MAINFRAME
IS MARKER AMPLITUDE EXCESSIVE?
REDUCE SETTING OF MARKERS ADJ CONTROL 18
IS MARKER AMPLITUDE STILL EXCESSIVE?
ADJUSTMENT WAS REQUIRED
ARE LEVELING AND 1 KHZ FUNCTIONS NORMAL?
IS MARKER WIDTH EXCESSIVE IN NARROW F1–F2 OR ΔF SWEEPS?
NORMAL OPERATION. SELECT ANOTHER MARKER MODE PER MAINFRAME MANUAL
NORMAL OPERATION. MARKER AMPLITUDE IS UNDEFINED IN LEVELING OFF MODE
IS OPERATION NORMAL IN LEVELED MODE?
OPERATE 5018 IN EXTERNALLY LEVELED MODE 19
IS 5018 OPERATING IN LEVELING OFF MODE?
IS 5018 OPERATING IN EXTERNALLY LEVELED MODE?
ARE MARKERS UNSTABLE?
CHECK MAIN-FRAME MARKERS OUT CONNECTOR FOR UNSTABLE MARKER PULSES 20
ARE MARKER PULSES NORMAL AT MAINFRAME?
SERVICE MAINFRAME
END
IS SWEEP RETRACE ABNORMAL?
CHECK SETTING OF RETRACE SWITCH 22
IS RETRACE NORMAL?
SWITCH SET TO WRONG POSITION
SERVICE MAINFRAME
IS 1 KHZ MODULATION ABNORMAL?
IS 1 KHZ SQUARE WAVE PRESENT WHEN 1 KHZ SWITCH IS SET TO ON?
ARE LEVELING AND 1 KHZ FUNCTIONS NORMAL?
CHECK MAIN-FRAME BLANKING OUTPUT CONNECTOR FOR 14–18 V PULSE AT SWEEP RETRACE 23
IS BLANKING PULSE NORMAL?
IS 5018 OPERATING IN LEVELING OFF MODE?
IS 5018 OPERATING IN EXTERNALLY LEVELED MODE?
5
IS 540-SERIES MAINFRAME USED?
IS 50520 SYSTEM (521 CONTROLLER) USED?
SELECT CW MODULATION MODE 26
IS FREQUENCY OF SQUARE WAVE ABNORMAL?
OPERATE 5018 IN EXTERNALLY LEVELED MODE 24
IS OPERATION NORMAL?
NORMAL OPERATION. SWEEP RETRACE MAY BE DISTORTED AT MAXIMUM UNLEVELED OUTPUT
ADJUST 1 KHZ ADJ CONTROL 25
CAN FREQUENCY BE ADJUSTED TO 1 kHz ±50 Hz?
ADJUSTMENT WAS REQUIRED
IS RISETIME OR FALLTIME OF SQUARE WAVE EXCESSIVE?
IS POWER METER LEVELING OPTION M7/M7A USED?
NORMAL OPERATION. RISE/FALL TIME SPECIFICATIONS DO NOT APPLY WHEN M7/M7A IS USED
ARE LEVELING AND RETRACE FUNCTIONS NORMAL?
CHECK P20-23 FOR 1 kHz SQUARE WAVE ≈2 Vp-p 27
IS SQUARE WAVE NORMAL?
CHECK CR13
DOES SQUARE WAVE HAVE EXCESSIVE OVERSHOOT?
RECALIBRATE PER ¶ 4-3.9.2
MEASURE ASSYMMETRY PER ¶ 4-2.11 28
RECALIBRATE PER ¶ 4-3.10
DOES SQUARE WAVE ASYMMETRY EXCEED 5%?
NO ADJUSTMENT REQUIRED
RECALIBRATE PER ¶ 4-3.9.2

Figure 5-1. Troubleshooting Diagram (Sheet 2)

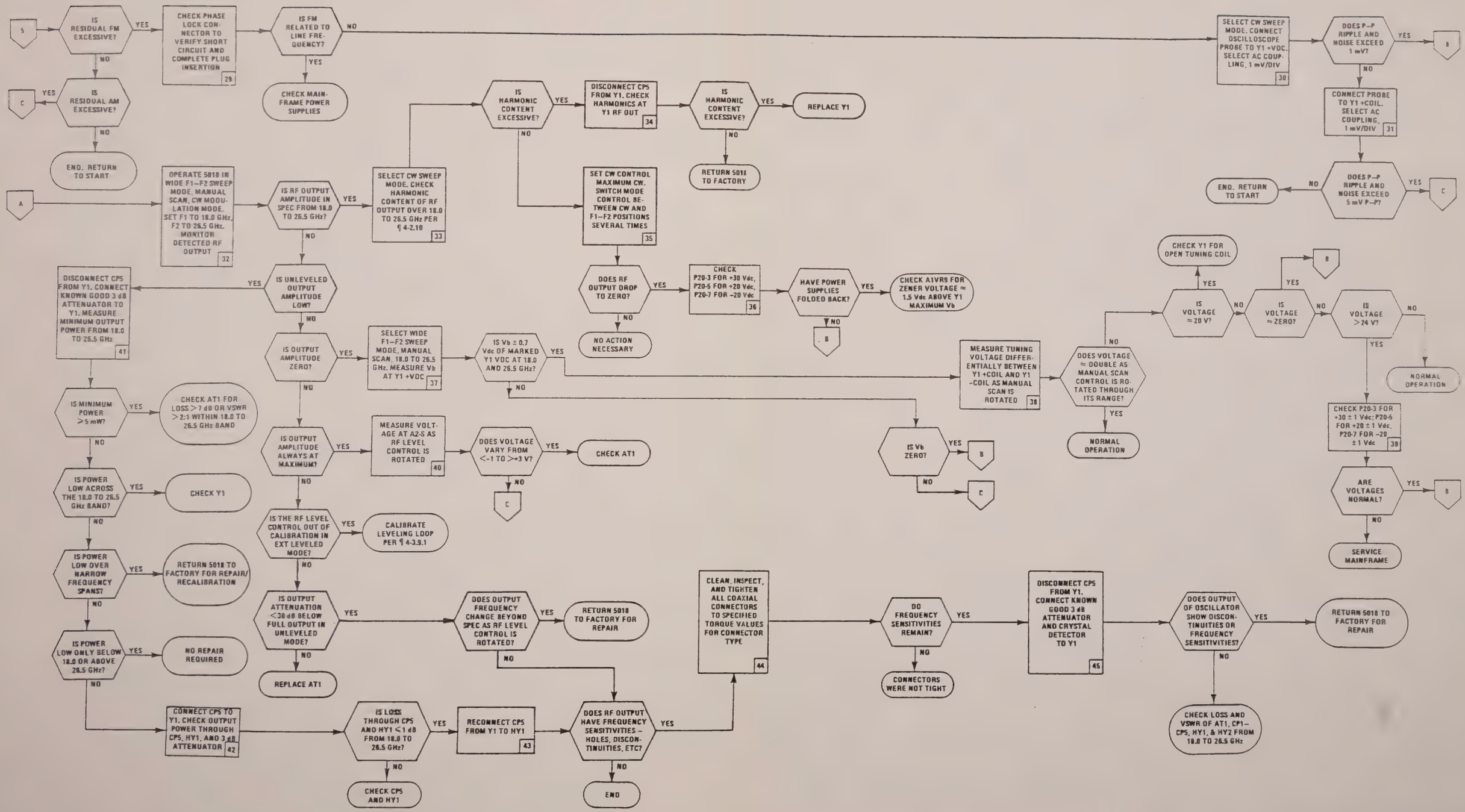

5
IS RESIDUAL FM EXCESSIVE?
YES
CHECK PHASE LOCK CONNECTOR TO VERIFY SHORT CIRCUIT AND COMPLETE PLUG INSERTION 29
IS FM RELATED TO LINE FREQUENCY?
YES
CHECK MAINFRAME POWER SUPPLIES
NO
IS RESIDUAL AM EXCESSIVE?
C
YES
NO
END. RETURN TO START
A
OPERATE 5018 IN WIDE F1–F2 SWEEP MODE, MANUAL SCAN, CW MODULATION MODE. SET F1 TO 18.0 GHz, F2 TO 26.5 GHz. MONITOR DETECTED RF OUTPUT 32
IS RF OUTPUT AMPLITUDE IN SPEC FROM 18.0 TO 26.5 GHz?
YES
SELECT CW SWEEP MODE. CHECK HARMONIC CONTENT OF RF OUTPUT OVER 18.0 TO 26.5 GHz PER ¶ 4-2.18 33
IS HARMONIC CONTENT EXCESSIVE?
YES
DISCONNECT CPS FROM Y1. CHECK HARMONICS AT Y1 RF OUT 34
IS HARMONIC CONTENT EXCESSIVE?
YES
REPLACE Y1
NO
RETURN 5018 TO FACTORY
NO
SET CW CONTROL MAXIMUM CW. SWITCH MODE CONTROL BETWEEN CW AND F1–F2 POSITIONS SEVERAL TIMES 35
DOES RF OUTPUT DROP TO ZERO?
YES
CHECK P20-3 FOR +30 Vdc, P20-5 FOR +20 Vdc, P20-7 FOR –20 Vdc 36
HAVE POWER SUPPLIES FOLDED BACK?
YES
CHECK A1VR9 FOR ZENER VOLTAGE ≈ 1.5 Vdc ABOVE Y1 MAXIMUM Vb
NO
B
NO
NO ACTION NECESSARY
IS UNLEVELED OUTPUT AMPLITUDE LOW?
YES
DISCONNECT CPS FROM Y1. CONNECT KNOWN GOOD 3 dB ATTENUATOR TO Y1. MEASURE MINIMUM OUTPUT POWER FROM 18.0 TO 26.5 GHz 41
NO
IS OUTPUT AMPLITUDE ZERO?
YES
SELECT WIDE F1–F2 SWEEP MODE, MANUAL SCAN, 18.0 TO 26.5 GHz. MEASURE Vb AT Y1 +VDC 37
IS Vb ± 0.7 Vdc OF MARKED Y1 VDC AT 18.0 AND 26.5 GHz?
YES
NO
IS MINIMUM POWER ≥5 mW?
YES
CHECK AT1 FOR LOSS > 7 dB OR VSWR > 2:1 WITHIN 18.0 TO 26.5 GHz BAND
NO
IS POWER LOW ACROSS THE 18.0 TO 26.5 GHz BAND?
YES
CHECK Y1
NO
IS POWER LOW OVER NARROW FREQUENCY SPANS?
YES
RETURN 5018 TO FACTORY FOR REPAIR/ RECALIBRATION
NO
IS POWER LOW ONLY BELOW 18.0 OR ABOVE 26.5 GHz?
YES
NO REPAIR REQUIRED
NO
CONNECT CPS TO Y1. CHECK OUTPUT POWER THROUGH CPS, HY1, AND 3 dB ATTENUATOR 42
IS OUTPUT AMPLITUDE ALWAYS AT MAXIMUM?
YES
MEASURE VOLTAGE AT A2-S AS RF LEVEL CONTROL IS ROTATED 40
DOES VOLTAGE VARY FROM <–1 TO >+3 V?
YES
CHECK AT1
NO
C
NO
IS THE RF LEVEL CONTROL OUT OF CALIBRATION IN EXT LEVELED MODE?
YES
CALIBRATE LEVELING LOOP PER ¶ 4-3.9.1
NO
IS OUTPUT ATTENUATION <30 dB BELOW FULL OUTPUT IN UNLEVELED MODE?
YES
DOES OUTPUT FREQUENCY CHANGE BEYOND SPEC AS RF LEVEL CONTROL IS ROTATED?
YES
RETURN 5018 TO FACTORY FOR REPAIR
NO
REPLACE AT1
IS LOSS THROUGH CPS AND HY1 < 1 dB FROM 18.0 TO 26.5 GHz?
YES
RECONNECT CPS FROM Y1 TO HY1 43
NO
CHECK CPS AND HY1
DOES RF OUTPUT HAVE FREQUENCY SENSITIVITIES – HOLES, DISCONTINUITIES, ETC?
YES
NO
END
CLEAN, INSPECT, AND TIGHTEN ALL COAXIAL CONNECTORS TO SPECIFIED TORQUE VALUES FOR CONNECTOR TYPE 44
DO FREQUENCY SENSITIVITIES REMAIN?
YES
NO
CONNECTORS WERE NOT TIGHT
DISCONNECT CPS FROM Y1. CONNECT KNOWN GOOD 3 dB ATTENUATOR AND CRYSTAL DETECTOR TO Y1 45
DOES OUTPUT OF OSCILLATOR SHOW DISCONTINUITIES OR FREQUENCY SENSITIVITIES?
YES
RETURN 5018 TO FACTORY FOR REPAIR
NO
CHECK LOSS AND VSWR OF AT1, CP1–CPS, HY1, & HY2 FROM 18.0 TO 26.5 GHz
MEASURE TUNING VOLTAGE DIFFERENTIALLY BETWEEN Y1 +COIL AND Y1 –COIL AS MANUAL SCAN IS ROTATED 38
IS Vb ZERO?
YES
B
NO
C
DOES VOLTAGE ≈ DOUBLE AS MANUAL SCAN CONTROL IS ROTATED THROUGH ITS RANGE?
NO
YES
NORMAL OPERATION
CHECK Y1 FOR OPEN TUNING COIL
IS VOLTAGE ≈ 20 V?
YES
NO
IS VOLTAGE ≈ ZERO?
YES
B
NO
IS VOLTAGE > 24 V?
YES
NO
NORMAL OPERATION
CHECK P20-3 FOR +30 ± 1 Vdc; P20-5 FOR +20 ± 1 Vdc, P20-7 FOR –20 ± 1 Vdc 39
ARE VOLTAGES NORMAL?
YES
B
NO
SERVICE MAINFRAME
SELECT CW SWEEP MODE. CONNECT OSCILLOSCOPE PROBE TO Y1 +VDC. SELECT AC COUPLING, 1 mV/DIV 30
DOES P–P RIPPLE AND NOISE EXCEED 1 mV?
YES
B
NO
CONNECT PROBE TO Y1 +COIL. SELECT AC COUPLING, 1 mV/DIV 31
DOES P–P RIPPLE AND NOISE EXCEED 5 mV P–P?
YES
C
NO
END. RETURN TO START

Figure 5-1. Troubleshooting Diagram (Sheet 3)

SECTION VI

THEORY OF OPERATION

6-1. OVERALL FUNCTIONAL DESCRIPTION (Figure 6-1)

Figure 6-1 is a simplified block diagram of the Model 5018 RF Plug-in. The user is also referred to the mainframe instruction manual, which describes the interconnections and interrelationships between the mainframe and RF plug-in.

The RF plug-in accepts operating power, frequency-control signals, and amplitude-control signals from the mainframe and generates a predictable band of microwave energy to be used for transmission and/or reflection tests of instruments, systems, or components designed for operation in the 18,000 to 26,500 megahertz range.

6-1.1 Oscillator Driver

Oscillator driver printed circuit assembly A1 accepts the frequency tuning output of the mainframe and sums this voltage with externally-supplied frequency modulation (FM) voltage (Option M6 only). The outputs of A1 drive the heatsink-mounted pass transistors to provide the oscillator module with a regulated current-mode frequency tuning signal (V_t) and programmed voltage-mode operating power (V_b).

Detailed circuit theory for Oscillator Driver A1 and associated circuits is contained in Section VIII of this manual.

6-1.2 Amplitude Modulation Functions

Amplitude modulation signals from the mainframe (retrace blanking and markers, plus 1 kilohertz and rf-off in some mainframes) and external amplitude modulation signals coupled through the mainframe are summed with leveling feedback signals from an external detector to control the RF output amplitude of the plug-in. Other drive signals generated within the plug-in (power, leveling mode, and 1 kilohertz modulation) also provide drive for the internal RF modulator. Model 5018's equipped with Option M7 or M7A accept the output of a microwave power meter as a leveling input.

Detailed circuit theory for Leveler/Amplitude Modulator A2 and associated circuits is contained in Section IX of this manual.

6-2. OSCILLATOR (Figure 6-2)

The oscillator module used in the 5018 is a YIG-tuned source of solid-state design and discrete-component construction. The oscillator is tuned to the desired frequency by passing a current through an electromagnet coil surrounding a sphere of YIG (yttrium-iron-garnet) material which has been doped with impurities.

The magnetic flux generated by the tuning coil aligns the poles of the YIG sphere; once the material has been magnetically saturated, it can be tuned to resonate at different frequencies at a rate of some 2.8 megahertz per Gauss (one Maxwell per square centimeter). This *uniform precessional mode*, as it is known, is defined as the condition in which the magnetic moments of all the atoms in the YIG crystal are parallel and precess in phase about the uniform magnetic field.

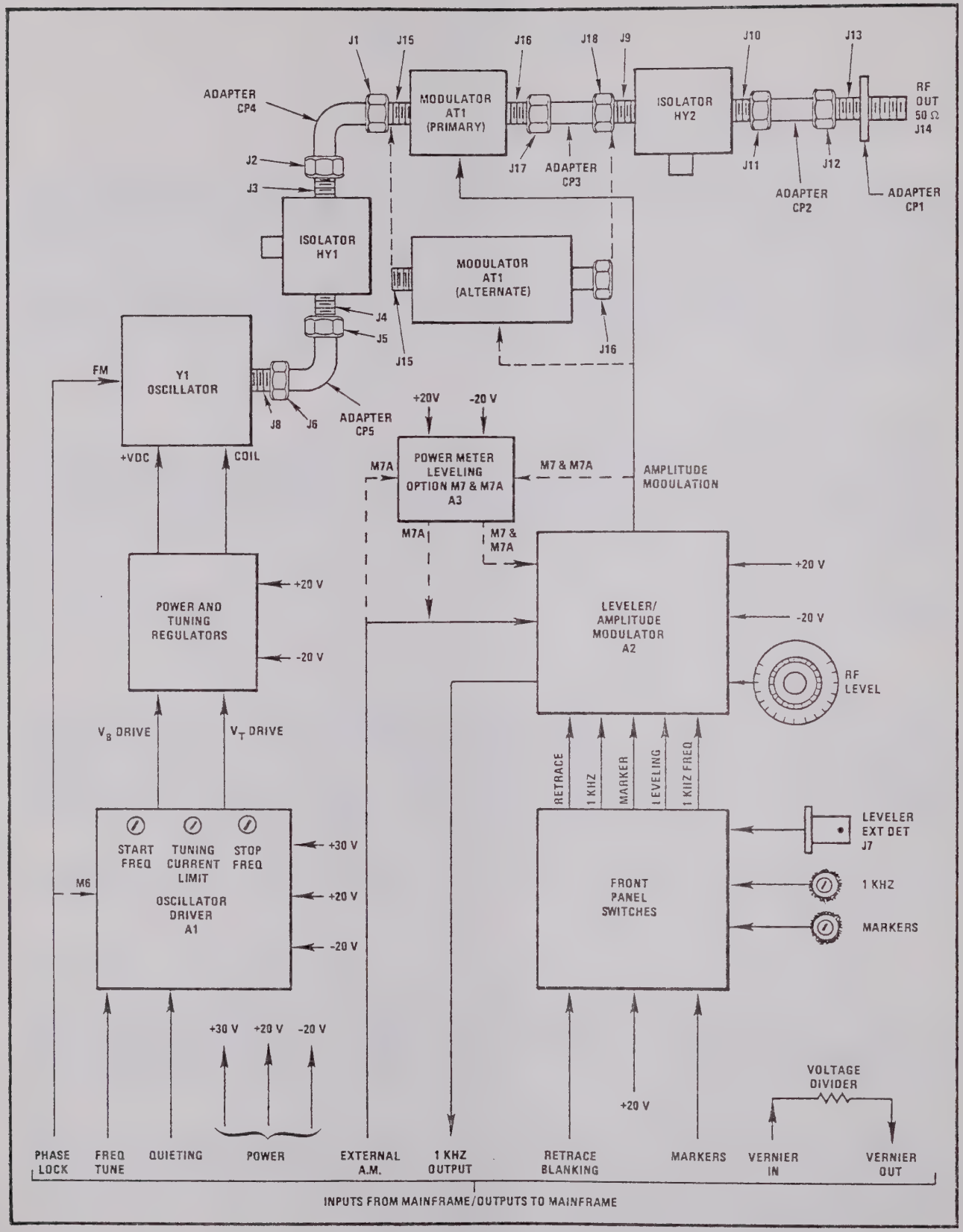


Figure 6-1. Model 5018 Block Diagram

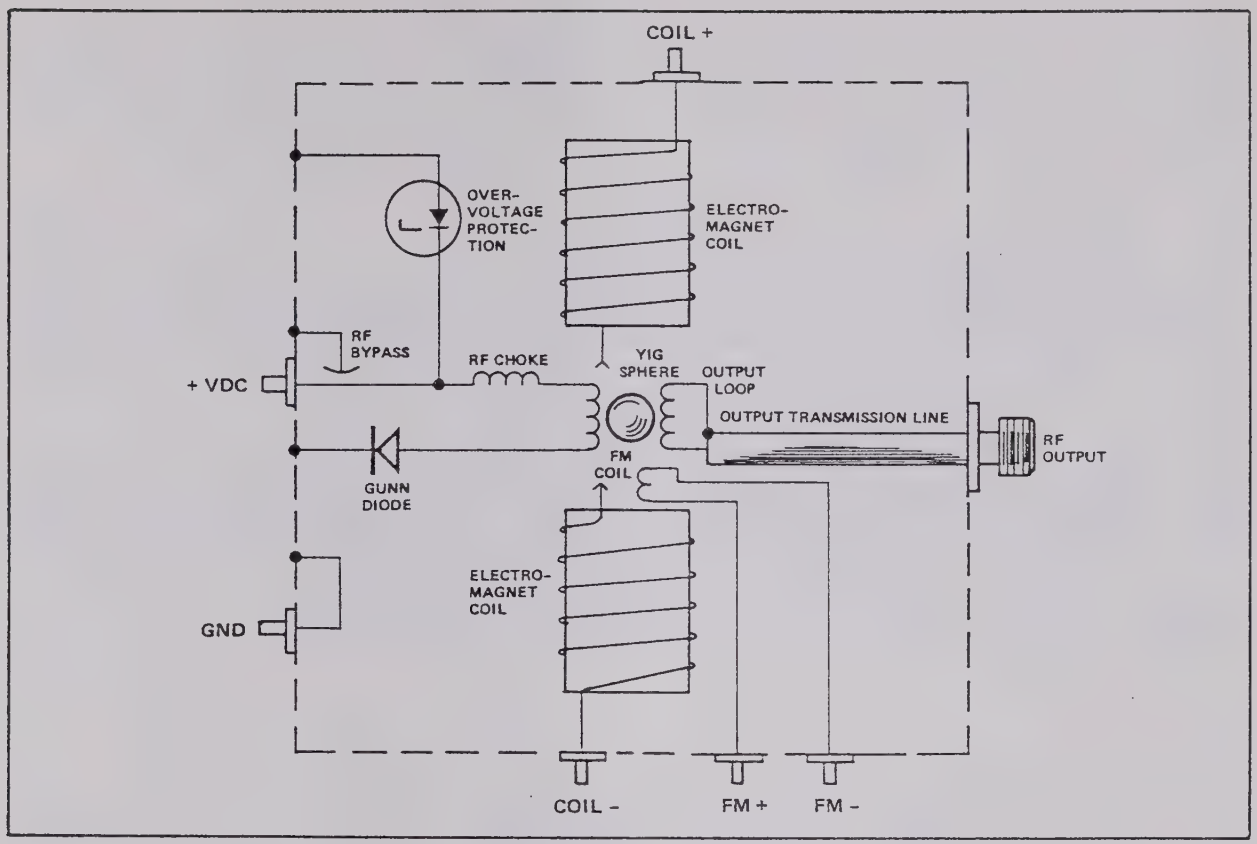


Figure 6-2. Simplified Construction of YIG-tuned Gunn Diode Oscillator

The main tuning coil sets the frequency output over the entire operating band of the oscillator. Once the YIG material has been saturated, it tunes linearly with applied electromagnet current. This results in a device which can be tuned predictably and linearly as a function of external drive current.

The oscillator module incorporates two tuning coils; the smaller tuning coil, which is mounted in intimate contact with the YIG sphere, is used for fast frequency modulation over relatively narrow bandwidths. This FM coil is not heavily coupled to the ferromagnetic material around which the main tuning coil is wound; its response is therefore much faster than that of the main tuning coil and hysteresis is so low as to be of no concern.

Oscillator module Y1 is a wideband unit covering the range of 18,000 to 26,500 megahertz. The active oscillator element is a Gunn-effect diode. The Gunn diode is mounted to a heatsink inside the oscillator and connected to the V_b supply through a short loop which passes over one side of the YIG sphere. The output loop passes over the opposite side of the sphere. The Gunn diode is tuned to frequency by varying the load impedance into which it is coupled. The magnetically-saturated YIG sphere acts as a variable impedance load, tuned by the magnetic saturation of the sphere.

6-3. RF MODULATOR

The RF output of the oscillator module is coupled through coaxial adapter CP5, isolator HY1, and adapter CP4 to the input of modulator assembly AT1. This device controls the output amplitude of the 5018 by acting as a current-controlled microwave attenuator.

Attenuator AT1 uses PIN diodes in a shunt configuration. The PIN diode is manufactured so that a thin intrinsic region separates the P material from the N material. The storage time of the PIN diode is relatively long, so it does not rectify at microwave frequencies. Instead, it behaves as a variable impedance controlled by a dc current through the diode. The amount of absorption or reflection of the modulator is controlled by the leveler/amplitude modulation circuits of the 5018.

6-4. ISOLATORS

The reflective properties of the modulator's PIN diodes under low-resistance operating conditions could affect oscillator operation and cause discontinuities in the output of the 5018. Isolators HY1 and HY2 are used to reduce the effects of modulator or load impedance changes. An isolator is a ferrite device which allows microwave energy to be passed through in one direction with a loss of less than 1 decibel, but absorbs RF energy reflected back from the load to the source.

Isolator HY1 prevents damage to the oscillator or distortion of its output signal which could result from PIN diode mismatches and impedance changes over the 30-decibel control range of the modulator. Isolator HY2 reduces the output VSWR of the 5018 while protecting the PIN diodes from the effect of energy reflected back to the modulator from mismatched load impedances at the RF OUT connector of the plug-in.

SECTION VII

CHASSIS ASSEMBLY

7-1. REPLACEABLE PARTS LIST

Table 7-3 in this section contains a list of replaceable parts and subassemblies for Model 5018 RF Plug-in Unit, including listings for Options M7 and M7A. Replaceable parts lists for oscillator driver subassembly A1 are found in Section VIII. Replaceable parts lists for leveler/amplitude modulator subassembly A2 and for power meter leveling subassembly A3 are found in Section IX.

7-1.1 Ordering Replacement Parts

The majority of the electronic parts used in the 5018 are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Systron-Donner Sales Representative.

Be sure to include the model number (5018, 5018M7, etc.) and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the reference designator where applicable.

7-1.2 Explanation of Table 7-3 Columns

7-1.2.1 FIG. NO./ITEM NO. This column references the figure numbers in which the part can be located and the parts location reference number in the parts breakdown drawing.

7-1.2.2 REF. DESIG. Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator. Reference designators for components not available separately, which may be ordered only as part of another subassembly, are listed in *italic type.*

7-1.2.3 USE CODE. An entry in this column indicates that the part may not be found in all 5018's because it is part of an option, a part replaced when an option is ordered, or an alternate part. Table 7-1 lists the use codes for Model 5018.

7-1.2.4 SYSTRON-DONNER PART NUMBER. All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

7-1.2.5 MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

7-1.2.6 MFR. CODE. The five-digit Federal Manufacturers' Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 7-2.

7-1.2.7 DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

Table 7-1. Model 5018 Chassis Assembly Use Codes

CODE	EXPLANATION
A	Alternate part; used when 5018 is equipped with Systron-Donner (Concord) modulator or when part listed is interchangeable with primary part
B	Component which is part of a subassembly within the 5018. The size or electrical value of the component is determined by its use in the 5018, and is listed in the chassis parts list. No size or value is shown in the parts list for the subassembly, only the use code "B".
F	Component supplied to Systron-Donner Microwave Division specifications. *Manufacturer's standard part may not meet 5018 performance specifications unless screened by Microwave Division incoming inspection.*
H	Modified part; physical alteration required from standard part as supplied by manufacturer before use in 5018.
K	Component electrically part of chassis assembly but mounted physically to a subassembly or component part within the 5018.
M	Part supplied as part of Option M7 or M7A.
P	Primary part; used when 5018 is equipped with Systron-Donner (Van Nuys) modulator or when part listed may be replaced by an alternate part.
S	Standard version; part supplied in normally-supplied 5018 which may be replaceable by an "M" part if an option is ordered.
T	Component size or electrical value is chosen by test as part of a calibration procedure.

7-1.2.8 QTY. The quantity of the listed part used in a particular application is listed in this column. For example, if four screws are used to mount a subassembly, the number "4" is entered in this column, even if all four of the screws are not shown on the drawing. If two screws identical to these are used elsewhere in the chassis to mount another subassembly, the part will be listed again with the number "2" entered in the *QTY* column. If the same type of screw is to be used to mount an optional component, the screw will be listed a third time with "1" entered in the *QTY* column and the appropriate use coding letter in the *USE CODE* column.

7-1.3 Parts Breakdown

Figures 7-1 is the illustrated parts breakdown for all current versions of the 5018; the item numbers shown are used to locate the parts description in Table 7-3. The figure may also be used as a disassembly and reassembly guide.

7-2. SCHEMATIC DIAGRAMS

Figure 7-2 is the schematic/wiring diagram for Model 5018. Schematic diagrams for the individual subassemblies A1, A2, and A3 are found in Sections VIII and IX.

Table 7-2. Manufacturers' Codes

CODE	NAME
01121	Allen Bradley Co., Milwaukee WI 53204
01220	Systron-Donner Corporation
02660	Bunker Ramo Corporation, Amphenol Connector Div., Broadview IL 60153
03508	General Electric Co., Semiconductor Products Dept., Auburn NY 13021
04713	Motorola, Inc., Semiconductor Products Group, Phoenix AZ 85008
06090	Raychem Corporation, Menlo Park, CA 94025
06383	Panduit Corporation, Tinley Park IL 60477
09353	C and K Components, Inc., Watertown MA 02172
16733	Cablewave Systems, Inc., North Haven CT 06473
24546	Corning Glass Works, Electronic Components Div., Bradford PA 16701
26233	USM Corp., Nyloc Fastener Div., Torrance CA 90510
52542	Systron-Donner Corporation, Instrument Division, Concord CA 94518
72982	Erie Technological Products, Inc., Erie PA 16512
78189	Illinois Tool Works, Shakeproof Div., Elgin IL 60120
79136	Waldes Kohinoor, Inc., Long Island City NY 11101
80294	Bourns, Inc., Instrument Div., Riverside CA 92506
83330	Herman H. Smith Co., Inc., Brooklyn NY 11207
84841	Milford Rivet and Machine Co., New England Div., Milford CT 06460
91637	Dale Electronics, Inc., Columbus NE 68601
93459	Weinschel Engineering Co., Inc., Gaithersburg MD 20760
94222	Southco, Inc., Lester PA 19113
95146	Alco Electronic Products, Inc., Lawrence MA 01842
96906	Military Standards promulgated under authority of Defense Standardization Manual 4120 3-M

Table 7-3. Model 5018 RF Plug-in Chassis Parts List

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
7-1							
1	A1		950926		01220	BOARD ASSY — OSCILLATOR DRIVER (Uncalibrated) Includes:	1
	A1C4	B	104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V	1
	A1CR12	B	105532	1N4446	03508	DIODE, Silicon, 75 PIV	1
	A1R11	B	105494	3305P-1-103	80294	RESISTOR, Variable, 10 kΩ ±5%, (Stop Frequency Adjust)	1
	A1R14	B	104886	RL07S114G	24546	RESISTOR, Metal Film, 110 kΩ ±2%, 1/4 W	1
	A1R16	B	104974	RC07GF225K	01121	RESISTOR, Carbon, 2.2 MΩ ±10%, 1/4 W	1
	A1R17	B	104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W	1
	A1R20	B	104974	RC07GF225K	01121	RESISTOR, Carbon, 2.2 MΩ ±10%, 1/4 W	1
	A1R24	B	104867	RL07S183G	24546	RESISTOR, Metal Film, 18 kΩ ±2%, 1/4 W	1
	A1R27	B	104972	RC07GF105K	01121	RESISTOR, Carbon, 1 MΩ ±10%, 1/4 W	1
	A1R28	B/T				RESISTOR, Value Selected at Test	1
	A1R29	B/T				RESISTOR, Value Selected at Test	1
	A1R38	B	104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W	1
	A1R45	B/T				RESISTOR, Value Selected at Test	1
	A1R46	B/T				RESISTOR, Value Selected at Test	1
	A1VR9	B/T				DIODE, Zener, Value Selected at Test	1
2	A2		950384		01220	BOARD ASSY — LEVELER/A.M. (Uncalibrated)	1
3	A3	M7	95060501		01220	BOARD ASSY — NEGATIVE POWER METER LEVELING	1
3	A3	M7A	95060502		01220	BOARD ASSY — POSITIVE POWER METER LEVELING	1
4	AT1	P/F	962291		01220	MODULATOR, RF, 18—26.5 GHz	1
4	AT1	A/F	96229101	067946	52542	MODULATOR, RF, 18—26.5 GHz	1
5	CP1		108768	1568	93459	ADAPTER, Coaxial, 3.5 mm bulkhead female to female	1
5	CP2		950924		01220	ADAPTER, Coaxial, 3.5 mm male to male (short) Consists of:	1
			922467		01220	BODY, Adapter, 3.5 mm (short)	
			922468		01220	CONDUCTOR, Center (short)	
7	CP3	P	950923		01220	ADAPTER, Coaxial, 3.5 mm male to male (long) Consists of:	1
			922465		01220	BODY, Adapter, 3.5 mm (long)	
			922466		01220	CONDUCTOR, Center (long)	
7	CP3	A				Not used with AT1 alternate part	0
8	CP4		108624	976	16733	ADAPTER, Coaxial, 3.5 mm male to male, 90° swept	1
9	CP5		108624	976	16733	ADAPTER, Coaxial, 3.5 mm male to male, 90° swept	1
10	CR13	K	105532	1N4446	03508	DIODE, Silicon, 75 PIV	1
11	HY1	F	962292		01220	ISOLATOR, 18—26.5 GHz	1
12	HY2	F	962292		01220	ISOLATOR, 18—26.5 GHz	1
—	J1			Part of CP4		CONNECTOR, 3.5 mm, male	1
—	J2			Part of CP4		CONNECTOR, 3.5 mm, male	1
—	J3			Part of HY1		CONNECTOR, 3.5 mm, female	1
—	J4			Part of HY1		CONNECTOR, 3.5 mm, female	1
—	J5			Part of CP5		CONNECTOR, 3.5 mm, male	1
—	J6			Part of CP5		CONNECTOR, 3.5 mm, male	1
13	J7		101155	UG-1094/U	02660	CONNECTOR, Receptacle, BNC female (LEVELER EXT DET)	1
—	J8			Part of Y1		CONNECTOR, 3.5 mm, female	1
—	J9			Part of HY2		CONNECTOR, 3.5 mm, female	1
—	J10			Part of HY2		CONNECTOR, 3.5 mm, female	1
—	J11			Part of CP2		CONNECTOR, 3.5 mm, male	1
—	J12			Part of CP2		CONNECTOR, 3.5 mm, male	1
—	J13			Part of CP1		CONNECTOR, 3.5 mm, female	1
—	J14			Part of CP1		CONNECTOR, 3.5 mm, female	1

Table 7-3. Model 5018 RF Plug-in Chassis Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
—	J15	P/A		Part of AT1		CONNECTOR, 3.5 mm, female	1
—	J16	P		Part of AT1		CONNECTOR, 3.5 mm, female	1
—	J16	A		Part of AT1		CONNECTOR, 3.5 mm, male	1
—	J17	P		Part of CP3		CONNECTOR, 3.5 mm, male	1
—	J17	A				Not used	0
—	J18	P		Part of CP3		CONNECTOR, 3.5 mm, male	1
—	J18	A				Not used	0
14	P20		107094	26-159-24P	02660	CONNECTOR, Plug, 24-pin male	1
15	Q102		101394	2N5190	04713	TRANSISTOR, NPN Silicon, 40 W	1
16	Q103		101394	2N5190	04713	TRANSISTOR, NPN Silicon, 40 W	1
17	R1	K	104870	RL07S243G	24546	RESISTOR, Metal Film, 24 kΩ ±2%, 1/4 W	1
18	R2	K	104815	RL07S391G	24546	RESISTOR, Metal Film, 390 Ω ±2%, 1/4 W	1
19	R3	K	104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W	1
20	R4		105500	WA1G012S103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (MARKER ADJ)	1
21	R5		105499	WA1G040P103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (RF LEVEL)	1
22	R6		105500	WA1G012S103UA	01121	RESISTOR, Variable, 10 kΩ ±10% (1 KHZ ADJ)	1
23	R8	K	104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W	1
24	R17	K/T				RESISTOR, Value Selected at Test	1
25	R18	K/T				RESISTOR, Value Selected at Test	1
26	R104		105439	RH-5-2.5	91637	RESISTOR, Wirewound, 2.5 Ω ±1%, 5 W	1
27	R105	P				Not used with AT1 primary part	0
27	R105	A				Not used with AT1 alternate part	0
28	S9		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (MARKERS)	1
29	S10		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (RETRACE)	1
30	S11		105711	7301	09353	SWITCH, Toggle, 3PDT (LEVELER)	1
31	S12		105698	MTA-106D	95146	SWITCH, Toggle, SPDT (1 KHZ)	1
32	S19	M7/M7A	105698	MTA-106D	95146	SWITCH, Toggle, SPDT (POWER METER)	1
33	Y1	F	962262		01220	OSCILLATOR, 18—26.5 GHz	1
34		H	105800	TM-1S4M	06383	ANCHOR, Strap, nylon no. 4	1
35		H	105797	TM-1S6M	06383	ANCHOR, Strap, nylon no. 6	5
36			922463		01220	BAR, Mounting, left bottom	1
37			92246301		01220	BAR, Mounting, left top	1
38			922462		01220	BAR, Mounting, right bottom	1
39			92246201		01220	BAR, Mounting, right top	1
40			922491		01220	BRACKET, Cable	1
41			104458	5133-12	79136	CLIP, E-Ring	2
42			922460		01220	HEATSINK, Oscillator	1
43			922177		01220	HEATSINK, Transistor	1
44		M7/M7A	934188		01220	INSULATOR, Circuit Board	1
45			94800421		01220	KNOB ASSEMBLY, RF Level	1
46			100509	1416-4	83330	LUG, Ground, internal tooth no. 4	1
47			104262	1497	83330	LUG, Ground, 3/8	1
48			108110	MK77-2	04713	MOUNTING KIT, Transistor Includes:	2
—						WASHER, Metal, special	1
—						WASHER, Insulating, mica	1
49			104629	N-1A	95146	NUT, Knurled,1/4-40	4
49		M7/M7A	104629	N-1A	95146	NUT, Knurled, 1/4-40	1
50			100941	511-041800-00	78189	NUT, Kep, 4-40	2
51				Supplied with S9,S10, S12	95146	NUT, 1/4-40	3
51				Supplied with S11	09353	NUT, 1/4-40	1
51		M7/M7A		Supplied with S19	95146	NUT, 1/4-40	1
52				Supplied with R4—R6	01121	NUT, 1/4-32	3
53				Supplied with J7	02660	NUT, 3/8-32	1
54				Supplied with CP1	93459	NUT, 5/16-32	1

Table 7-3. Model 5018 RF Plug-in Chassis Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION	QTY.
55		S	915127		01220	PANEL ASSEMBLY, Front	1
						Order with:	
56			104515	51-18-106-24	94222	HOLDER, Captive Screw	1
57			96204899		01220	PLATE, Model	1
58			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
55		M7/M7A			01220	PANEL ASSEMBLY, Front	1
						Order with:	
56			104515	51-18-106-24	94222	HOLDER, Captive Screw	1
57			96203899		01220	PLATE, Model	1
58			100617	50x7/64 NI BRS	84841	RIVET, Model Plate Mounting	2
59			92201101		01220	PANEL, Rear	1
60			922016		01220	PLATE, Dial Scale Mounting	2
61			922464		01220	PLATE, Potentiometer/Connector Mounting	1
62			934229		01220	SCALE, Frequency Dial, 18—26.5 GHz	1
63			104516	51-18-108-24	94222	SCREW, Knurled, captive	1
64			928018		01220	SCREW, Knurled, dial scale	2
65			104609		01220	SCREW, Fillister Head, 6-32 x 5/16	2
66			10072005	MS24693C3	96906	SCREW, Flat Head Phillips, 4-40 x 5/16	2
67			10817205	By description	26233	SCREW, Flat Head Phillips, locking, 6-32 x 5/16, 100°	4
68			10817205	By description	26233	SCREW, Flat Head Phillips, locking, 6-32 x 5/16, 100°	4
69			10817205	By description	26233	SCREW, Flat Head Phillips, locking, 6-32 x 5/16, 100°	4
70			104601		01220	SCREW, Oval Head Phillips, 6-32 x 5/16, 32°	4
71			10062503	MS51957-2	96906	SCREW, Pan Head Phillips, 2-56 x 3/16	2
72			10062602	MS51957-11	96906	SCREW, Pan Head Phillips, 4-40 x 1/8	1
73			10816604	By description	26233	SCREW, Pan Head Phillips, locking, 4-40 x 1/4	2
74			10062605	MS51957-14	96906	SCREW, Pan Head, locking, 4-40 x 5/16	4
75			10062605	MS51957-14	96906	SCREW, Pan Head, locking, 4-40 x 5/16	2
76			10063202	MS51957-24	96906	SCREW, Pan Head Phillips, 6-32 x 1/8	4
77			10816703	By description	26233	SCREW, Pan Head Phillips, locking, 6-32 x 3/16	2
78		S	10816703	By description	26233	SCREW, Pan Head Phillips, locking, 6-32 x 3/16	2
79		M7/M7A	10063214	MS51957-33	96906	SCREW, Pan Head Phillips, 6-32 x 7/8	2
80			10816705	By description	26233	SCREW, Pan Head Phillips, locking, 6-32 x 5/16	4
81			928706		01220	SHIELD, Magnetic	1
82		M7/M7A	104563	8583	83330	SPACER, Hexagonal, no. 6 x 1/2	2
83			100753	SST-1	06383	STRAP, Cable Tie, nylon	8
84			108188	RT876 1/8 BLK	06090	TUBING, Heat-Shrink, 1/8 dia x 1/2	2
85			104463	2160	83330	WASHER, Flat Fiber, no. 6	8
86		M7/M7A	104463	2160	83330	WASHER, Flat Fiber, no. 6	2
87				Supplied with J7	02660	WASHER, Lock, internal tooth, 3/8	1
88				Supplied with CP1	93459	WASHER, Lock, external tooth, 1/4	1
89			100661	MS35337-77	96906	WASHER, Lock, split, no. 2	2
90			100712	MS35338-136	96906	WASHER, Lock, split, no. 6	4
91		M7/M7A	100712	MS35338-136	96906	WASHER, Lock, split, no. 6	2
92				Supplied with S9,S10, S12	95146	WASHER, Switch Locating	3
92				Supplied with S11	09353	WASHER, Switch Locating	1
92		M7/M7A		Supplied with S19	95146	WASHER, Switch Locating	1

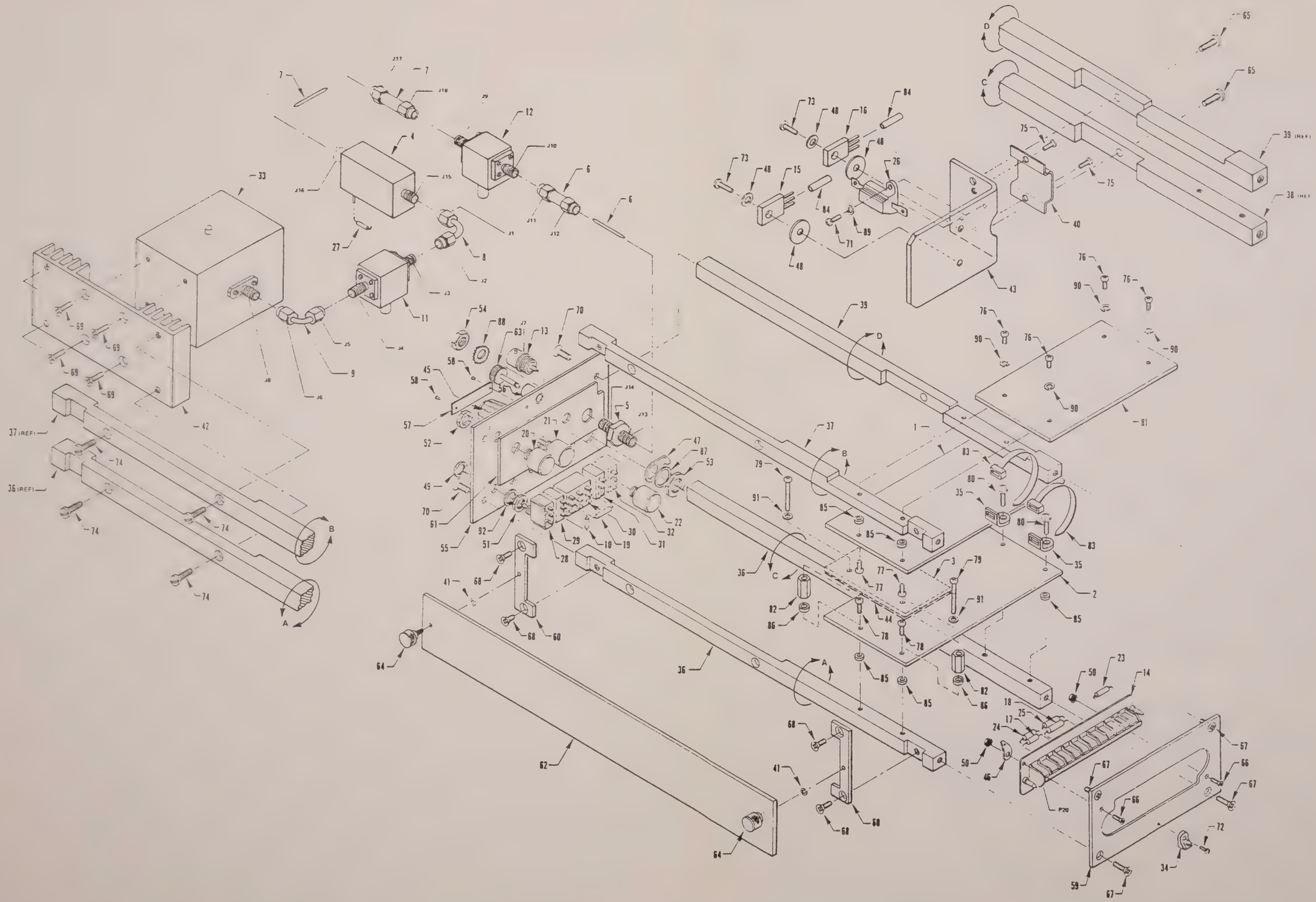
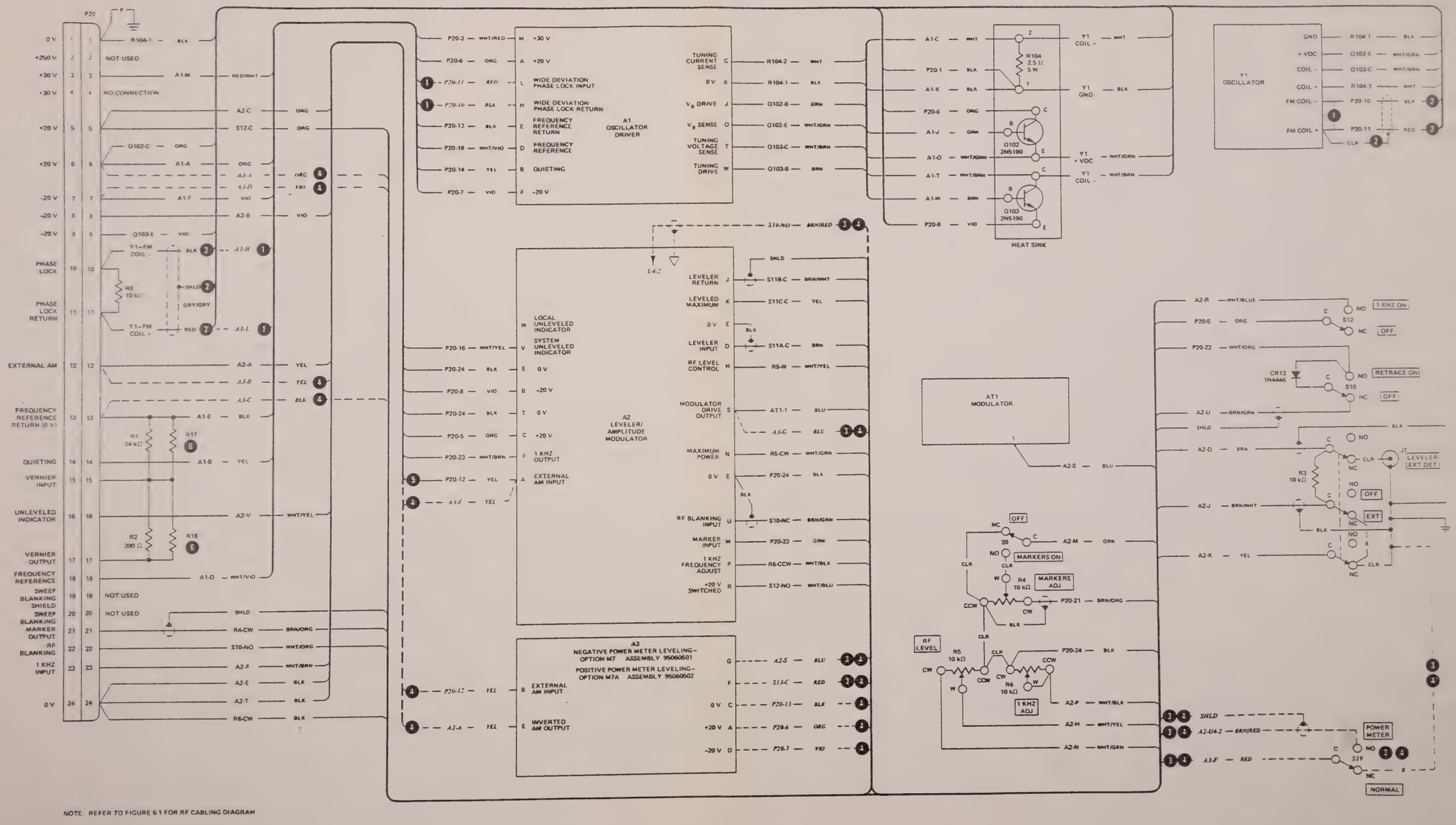


Figure 7-1. Model 5018 RF Plug-in Illustrated Parts Breakdown



NOTE: REFER TO FIGURE 6-1 FOR RF CABLING DIAGRAM

Figure 7-2. Model 5018 RF Plug-in Schematic/Wiring Diagram

SECTION VIII

OSCILLATOR DRIVER

8-1. GENERAL

This section contains circuit theory, trouble isolation information, a replaceable parts list, and a schematic diagram with parts location and test point information for Oscillator Driver Printed Circuit Board Assembly A1. Overall plug-in and microwave component operating theory for the RF plug-in containing A1 may be found in Section VI, with the plug-in chassis interconnect wiring diagram and parts list in Section VII.

8-2. THEORY OF OPERATION (Figure 8-1)

The YIG-tuned oscillator used in the plug-in unit has a tuning curve which is inherently linear, and requires operating and tuning drive currents as high as 800 milliamperes. The oscillator driver board is used to provide operating power and to convert the frequency reference voltage from the mainframe into current drive for the main tuning coil in the oscillator. The oscillator driver also contains protective circuitry for the oscillator element and tuning circuits.

8-2.1 Operating Power

A programmable remote-sensing power supply comprising an integrated-circuit error amplifier and pass transistor (with several protective devices) provides operating power for the active oscillator element in the oscillator module. (Operating power for Gunn-diode oscillators is abbreviated V_b. Depending upon manufacturer, operating power for transistor oscillators is abbreviated V_c or V_b.) The required V_b/V_c level is determined by the output of operational amplifier A1U7, based upon the levels of the three inputs to A1U7:

1. V_b/V_c sensing feedback from heatsink-mounted regulator transistor Q102. The voltage level sensing feedback is coupled through terminal O of A1 and the voltage divider comprising resistors A1R36/R37 and A1R34/R35 into the inverting summing junction of A1U7.

2. A programming input from tuning summer/inverter A1U1 through A1R45 into the inverting summing junction of A1U7.

3. An offsetting bias from a stable 6.2 volt reference (A1VR7) into the non-inverting summing junction of A1U7 through A1R33.

These inputs are summed together in A1U7, which delivers a positive-polarity base current drive output for regulator transistor Q102 mounted to the chassis heatsink. The regulator transistor, in turn, provides operating voltage from the plus 20 or plus 30 volt mainframe power supply for the oscillator module. The oscillator requires a stable, well-regulated voltage source; different oscillator modules, though bearing the same manufacturer's model number, will probably require different operating voltages. This voltage is usually specified on the nameplate label or on a test data sheet supplied with the module. The range of voltages varies from less than 5 to more than 15. (When oscillators which require voltages below 6.2 volts are used, resistor A1R46 forms a voltage divider with A1R33 to reduce the output of A1U7 below its normal minimum of 6.2 volts.)

Capacitor A1C14 filters out short-term voltage changes and perturbations to maintain low noise in the V_b/V_c output.

8-2.2 Overvoltage and Reverse Polarity Protection

The operating voltage at the oscillator V_b/V_c terminals, in addition to being coupled into the error amplifier, is also fed to the protective circuitry of the oscillator driver.

The V_b/V_c level is limited to the reverse-avalanche level of Zener diode A1VR9; this diode is selected at test for a voltage approximately 1.5 volts above the highest level required by the oscillator. Should the V_b /V_c reach this limit, through malfunction of A1U7 or test connection error, current will flow through A1VR9 and A1R38 to ground. The voltage developed across A1R38 will fire silicon-controlled rectifier (SCR) A1Q8 to reduce the output of A1U7 to zero and turn off regulator transistor Q102. The SCR will not open until mainframe power is turned off.

In the event that Q102 suffers an emitter-collector short circuit, diode A1CR8 prevents the full power supply voltage from damaging the oscillator: current is conducted through A1CR8 and A1VR9, firing SCR A1Q8. The resulting short circuit to ground will drive the mainframe power supply into its current-limit mode and reduce the voltage applied to the oscillator to less than one-half volt.

Should the V_b/V_c level become negative, through malfunction of a component or connection error during test or troubleshooting operations, diode A1VR9 will conduct all current through A1R38 to ground.

The oscillator module itself is fitted with a factory-selected Zener diode for further overvoltage or reverse-polarity protection; this diode is internal in some oscillators and visible on external terminals in others. This diode prevents destruction of the oscillator element in the event of a malfunction in regulator Q102 by acting as a short circuit and driving the mainframe power supply into current limiting.

8-2.3 Programming

In order to obtain optimum oscillator performance in some plug-ins, the operating voltage is programmed over the swept frequency range.

8-2.3.1 GUNN DIODE OSCILLATORS. In Gunn diode oscillator modules, programming is utilized to obtain the highest output power over the widest frequency range possible. These Gunn-diode oscillators require a higher low-frequency V_b than the V_b used at the high frequencies to achieve optimum power output over the band.

A portion of the inverted (zero to plus 10 volts) tuning voltage output of summer/inverter A1U1 is coupled through resistor A1R45 to the inverting summing junction of A1U7. At the lowest operating frequency, the frequency reference input voltage is near zero; consequently, the output of A1U1 is zero. As the tuning voltage from the mainframe increases (to a maximum of minus 10 volts), the output of A1U1 increases (to a maximum of plus 10 volts). Current is coupled through A1R45 into the inverting summing junction of A1U7, which reduces the output of A1U7 to Q102. Consequently, the V_b level is reduced as the tuning drive of the oscillator increases. Diode A1CR12 prevents the output of A1U1 from going negative in response to a momentary pulse or inadvertent connection of a positive-going *external tune* signal. A negative output from A1U1 could possibly increase the programmed V_b to excessive levels.

8-2.3.2 TRANSISTOR OSCILLATORS. Programming is used with some YIG-tuned transistor oscillators to reduce the harmonic content of the oscillator's output signal. To accomplish this, it is necessary to increase the V_c with increasing V_t.

The programming resistor is connected directly to the negative-going frequency reference input of A1U1. As this negative input to the inverting summing junction of A1U7 is increased, the positive output of A1U7 rises to increase the V_c at the oscillator terminals. (Diode A1CR12 is not used with transistor oscillators.)

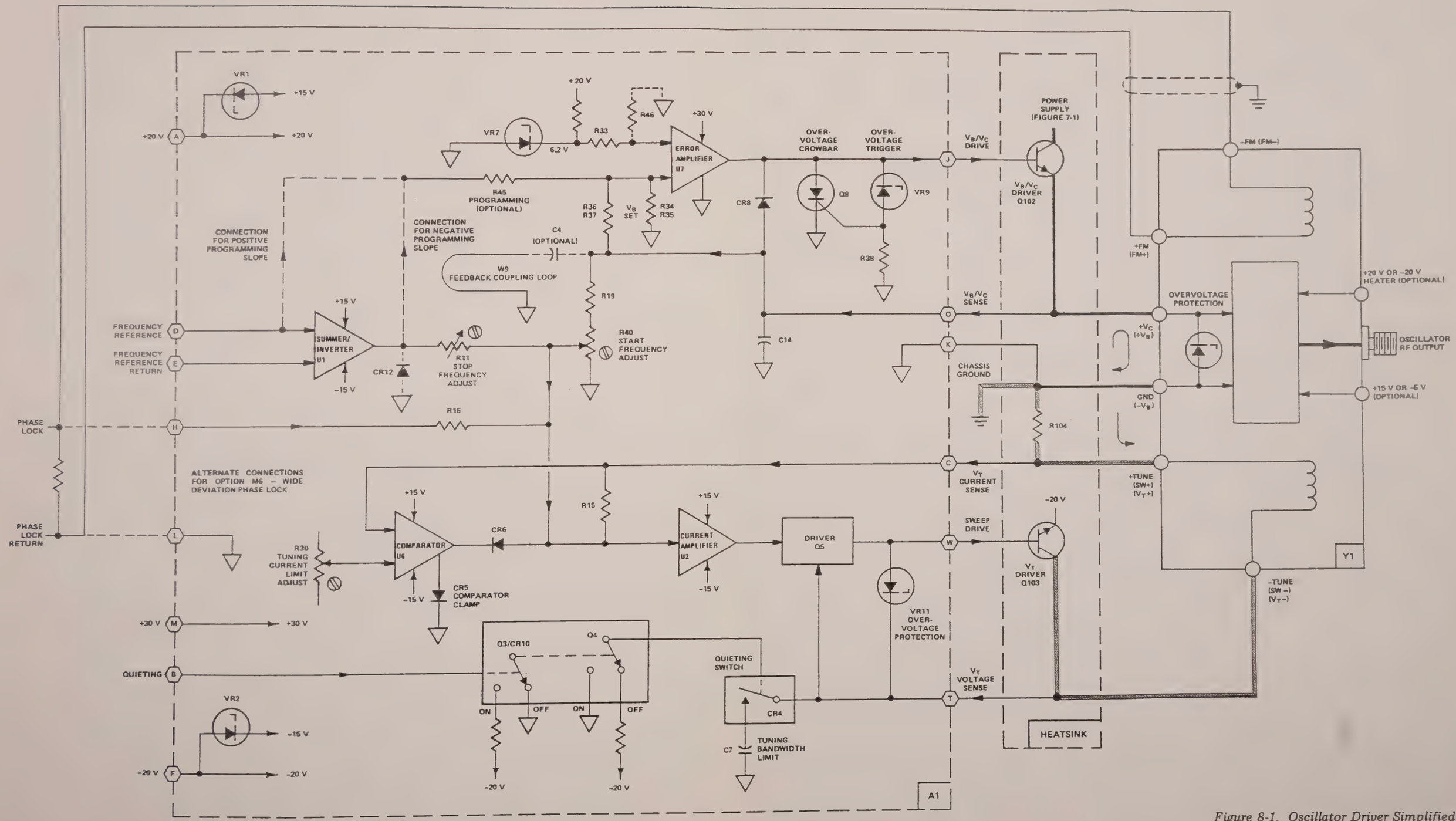


Figure 8-1. Oscillator Driver Simplified Schematic Diagram

8-2.4 Frequency Tuning

This frequency reference output of the mainframe is differentially coupled to operational amplifier A1U1 of the oscillator driver; this device is connected as an inverting current summer operating with a voltage gain of minus 1. The differential connection assures that any common mode noise — unwanted signals appearing on the frequency reference input and on the return — are ignored. This considerably reduces the effect of line-frequency and other extraneous conducted or radiated emissions upon the output frequency of the driven oscillator.

8-2.4.1 TUNING CURRENT AMPLIFIER. Operational amplifier A1U2, driver transistor A1Q5, and tuning current regulator transistor Q103 form a voltage-to-current amplifier which drives the main tuning coil in the oscillator. The amplifier is capable of delivering currents greater than 1 Ampere, and operates in a closed loop. Tuning current flows from the return of the minus 20 volt supply through tuning current sense resistor R104 and transistor Q103 to the +TUNE (or SW+ or V_t+) terminal of the oscillator; current flow continues through the tuning coil to the - 20 volt supply.

The voltage developed across sense resistor R104 is applied as feedback to tuning amplifier A1U2. The current through the tuning coil (and consequently the operating frequency of the oscillator) is determined by the algebraic sum of the current values into the summing junction of A1U2:

1. Start frequency (dc offset) from the V_b/V_c supply through variable resistor A1R40

2. Stop frequency (upper dc limit) from the inverted tuning output of A1U1 through variable resistor A1R11

3. Tuning coil current-sense feedback through resistor A1R15.

8-2.4.2 TUNING CURRENT LIMIT. If the sensed tuning current exceeds a predetermined limit set by variable resistor A1R30, comparator A1U6 will change state and hold the tuning current amplifier to its maximum allowable value. This action prevents the oscillator from being driven beyond its normal operating band by transients or excessive external FM input levels. Some Gunn-diode oscillator modules may be driven into a "locked" mode where the RF output is reduced to zero. In that case, the circuitry may be reset by turning off the mainframe power switch, waiting about 15 seconds, then turning the power back on. The tuning current limit is generally not needed with YIG-tuned transistor oscillators; the circuit is disabled by leaving out calibration resistors A1R28 and A1R29.

8-2.4.3 QUIETING. When the sweeper is operated in a non-swept mode — CW or manual sweep — a quieting input from the mainframe activates quieting switch A1Q3/A1CR10/A1Q4/A1CR4 to connect capacitor A1C7 from the output of tuning current driver A1Q5 to ground. This reduces the tuning bandwidth of the amplifier to less than 10 hertz, reducing incidental noise and residual FM in the RF output.

The mainframe quieting input at terminal B of A1 is approximately 4.5 to 5 volts positive (a digital "1"). Current from the quieting input is conducted through resistor A1R4 and diode A1CR10 to ground. The voltage level at the base of A1Q3 becomes plus 600 millivolts, the forward voltage drop across A1CR10. This turns A1Q3 off, and the increased negative level at the base of A1Q4 turns it on. Diode A1CR4, which had been back-biased by the negative voltage at its anode through A1R8, becomes forward biased and switches A1C7 into the tuning output of A1Q5.

8-2.4.4 FM TUNING INPUTS. An external frequency-modulation signal can be coupled through the mainframe directly to the auxiliary YIG tuning coil in the oscillator. The FM coils used in the various oscillator types have a resistance ranging from 500 milliohms to one ohm, and tuning sensitivities from 150 to 450 kilohertz per milliampere. The output frequency of the oscillator is reduced with negative

drive and increased with positive drive, to the band-edge limits. When the phase lock input is connected as a wide tuning input to terminal H of A1, the sensitivity to external inputs is 46 megahertz per volt to the band edges. Positive inputs increase the frequency.

8-3. TROUBLE ISOLATION

Figure 8-2 is an aid to trouble isolation in the oscillator driver components. This table should be used with the supporting information listed below:

1. The circuit descriptions and simplified schematic diagram in Paragraph 8-2 of this section.

2. Schematic diagram and parts location drawing Figure 8-3 at the end of this section; this drawing includes basing diagrams of the multi-lead semiconductor devices used on A1.

Begin trouble isolation procedures with Figure 5-2 of Section V before attempting trouble isolation to the component level on A1.

8-4. REPLACEABLE PARTS LIST

Table 8-2 in this section contains a list of replaceable parts for Oscillator Driver Assembly A1. Replaceable parts lists for the chassis assembly are found in Section VII. Replaceable parts lists for leveler/amplitude modulator subassembly A2 and for power meter leveling subassembly A3 are found in Section IX.

8-4.1 Ordering Replacement Parts

The majority of the electronic parts used in construction of the A1 board assembly are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Scientific Devices office.

Be sure to include the model number and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the A1 reference designator where applicable.

8-4.2 Explanation of Columns

8-4.2.1 FIG NO. This column references the figure number of the drawings in which the part can be located.

8-4.2.2 REF. DESIG. Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator.

8-4.2.3 USE CODE. An entry in this column indicates that the part may not be found in all units because it is part of an option, a part replaced when an option is ordered, or an alternate part. The size or electrical value of a component coded "B" is determined by its use in the RF plug-in, and is listed in the chassis parts list. No size or value is shown on the parts list for A1 (refer to Table 7-3, Section VII). The component size or electrical value of a component coded "T" is chosen by test as part of a calibration procedure.

8-4.2.4 SYSTRON-DONNER PART NUMBER. All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

8-4.2.5 MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

8-4.2.6 MFR. CODE. The five-digit Federal Manufacturers Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 8-1.

8-4.2.7 DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

8-5. SCHEMATIC DIAGRAMS

Figure 8-3 is the A1 board parts location drawing and schematic diagram. Schematic diagrams for the A2 and A3 boards are found in Section IX; the chassis wiring diagram is in Section VI.

Table 8-1. Manufacturers' Codes

CODE	NAME
01121	Allen Bradley Co., Milwaukee WI 53204
01220	Systron-Donner Corporation,
01686	AMF, Inc., RCL Electronics Division, Manchester NH 03102
03508	General Electric Co., Semiconductor Products Dept., Auburn NY 13021
04713	Motorola, Inc., Semiconductor Products Group, Phoenix AZ 85008
12969	Unitrode Corporation, Watertown MA 02172
24546	Corning Glass Works, Bradford PA 16701
27014	National Semiconductor Corp., Santa Clara CA 95051
31433	Union Carbide Corp., Components Dept., Greenville SC 29606
56289	Sprague Electric Co., North Adams MA 01247
71002	Birnbach Co., Inc., Freeport LI NY 11520
72136	Electro-Motive Manufacturing Co., Inc., Subsidiary of International Electronics Corp., Florence SC 29501
72982	Erie Technological Products, Erie PA 16512
80294	Bourns, Inc., Instrument Division, Riverside CA 92506
99942	Centralab Electronics, Division of Globe-Union, Inc., Milwaukee WI 53201

OSCILLATOR Y1 TERMINAL NOMENCLATURE CROSS-REFERENCE								
MANUFACTURER	Systron-Donner (Early)	Systron-Donner (Late)	Varian (Early)	Varian (Late)	Avantek	Watkins-Johnson (Late)	OmniYig	Term Used in Fig. 8-2
FUNCTION:								
Operating Power	6	V_b+	V_B+	V_B+	+V_c or +15V	+V_{DC}	6	+V_b
Power Return	5	GND	V_B–	GND	Not Marked	GND	5	Chassis
Main Tuning Coil	1	TUN+	SW+	SW+	+TUNE	COIL+	1	+TUNE
Main Coil Return	2	TUN–	SW–	SW–	–TUNE	COIL–	2	–TUNE
FM Tuning Coil	7	FM+	FM+	FM+	+FM	FM Coil+	4	+FM
FM Coil Return	8	FM–	FM–	FM–	–FM	FM Coil–	3	–FM
Heater	3	HTR	Not Used	Not Used	HTR	Not Used	8	+HTR
Heater Return	4	HTR	Not Used	Not Used	HTR	Not Used	7	–HTR
Auxiliary Operating Power	Not Used	Not Used	Not Used	Not Used	+15V or –5 V	Not Used	Not Used	Auxiliary Power

Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 1)

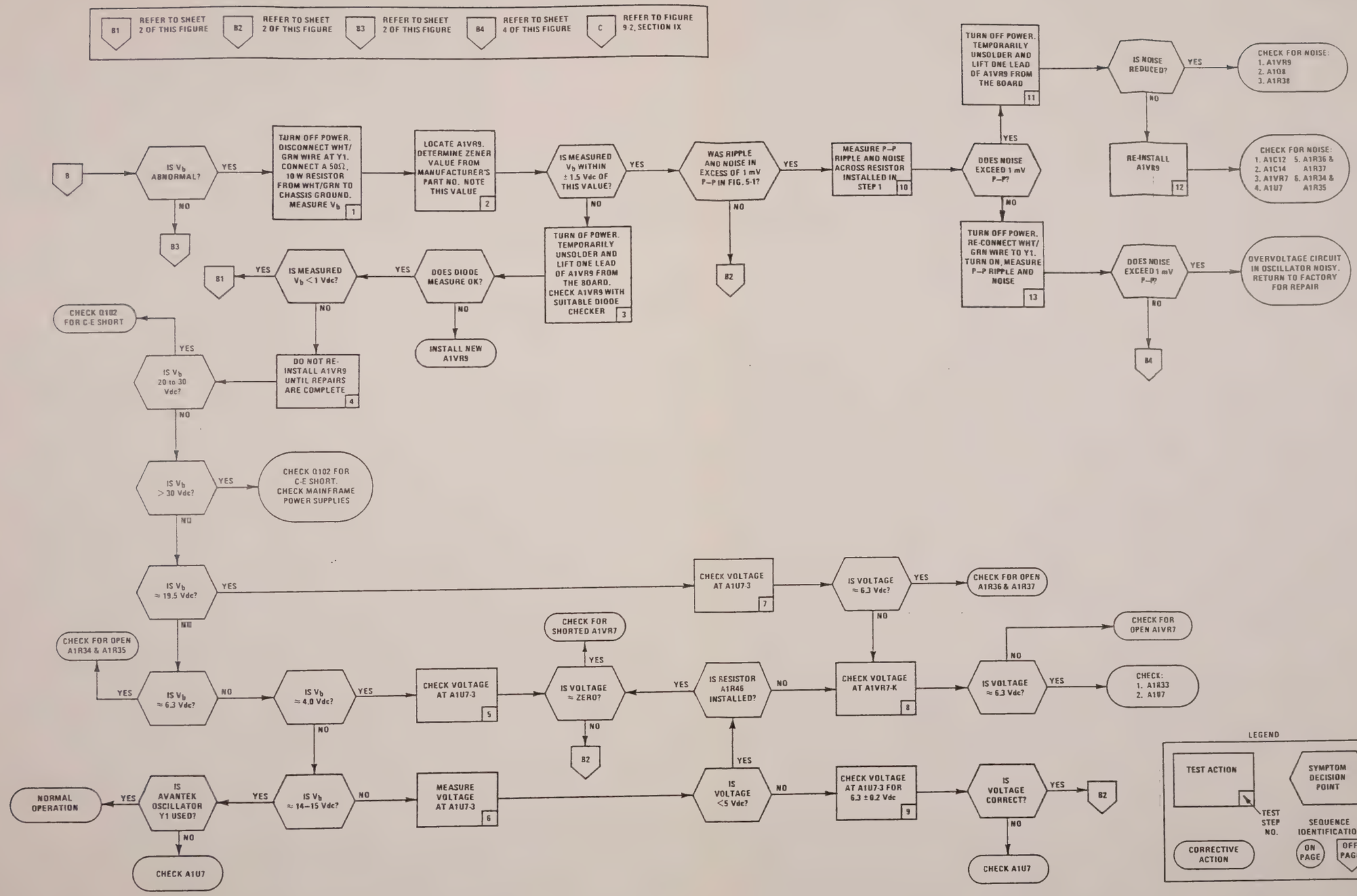

B1 REFER TO SHEET 2 OF THIS FIGURE
B2 REFER TO SHEET 2 OF THIS FIGURE
B3 REFER TO SHEET 2 OF THIS FIGURE
B4 REFER TO SHEET 4 OF THIS FIGURE
C REFER TO FIGURE 9-2, SECTION IX
B
IS V_b ABNORMAL?
YES
NO
TURN OFF POWER. DISCONNECT WHT/GRN WIRE AT Y1. CONNECT A 50Ω, 10 W RESISTOR FROM WHT/GRN TO CHASSIS GROUND. MEASURE V_b 1
LOCATE A1VR9. DETERMINE ZENER VALUE FROM MANUFACTURER'S PART NO. NOTE THIS VALUE 2
IS MEASURED V_b WITHIN ± 1.5 Vdc OF THIS VALUE?
TURN OF POWER. TEMPORARILY UNSOLDER AND LIFT ONE LEAD OF A1VR9 FROM THE BOARD. CHECK A1VR9 WITH SUITABLE DIODE CHECKER 3
DOES DIODE MEASURE OK?
INSTALL NEW A1VR9
IS MEASURED V_b < 1 Vdc?
DO NOT RE-INSTALL A1VR9 UNTIL REPAIRS ARE COMPLETE 4
CHECK Q102 FOR C-E SHORT
IS V_b 20 to 30 Vdc?
IS V_b > 30 Vdc?
CHECK Q102 FOR C-E SHORT. CHECK MAINFRAME POWER SUPPLIES
WAS RIPPLE AND NOISE IN EXCESS OF 1 mV P–P IN FIG. 5-1?
MEASURE P–P RIPPLE AND NOISE ACROSS RESISTOR INSTALLED IN STEP 1 10
DOES NOISE EXCEED 1 mV P–P?
TURN OFF POWER. TEMPORARILY UNSOLDER AND LIFT ONE LEAD OF A1VR9 FROM THE BOARD 11
IS NOISE REDUCED?
CHECK FOR NOISE: 1. A1VR9 2. A108 3. A1R38
RE-INSTALL A1VR9 12
CHECK FOR NOISE: 1. A1C12 2. A1C14 3. A1VR7 4. A1U7 5. A1R36 & A1R37 6. A1R34 & A1R35
TURN OFF POWER. RE-CONNECT WHT/GRN WIRE TO Y1. TURN ON, MEASURE P–P RIPPLE AND NOISE 13
DOES NOISE EXCEED 1 mV P–P?
OVERVOLTAGE CIRCUIT IN OSCILLATOR NOISY. RETURN TO FACTORY FOR REPAIR
IS V_b ≈ 19.5 Vdc?
CHECK FOR OPEN A1R34 & A1R35
IS V_b ≈ 6.3 Vdc?
IS V_b ≈ 4.0 Vdc?
CHECK VOLTAGE AT A1U7-3 5
IS VOLTAGE ≈ ZERO?
CHECK FOR SHORTED A1VR7
IS RESISTOR A1R46 INSTALLED?
CHECK VOLTAGE AT A1U7-3 7
IS VOLTAGE ≈ 6.3 Vdc?
CHECK FOR OPEN A1R36 & A1R37
CHECK VOLTAGE AT A1VR7-K 8
IS VOLTAGE ≈ 6.3 Vdc?
CHECK FOR OPEN A1VR7
CHECK: 1. A1R33 2. A107
IS V_b ≈ 14–15 Vdc?
MEASURE VOLTAGE AT A1U7-3 6
IS VOLTAGE <5 Vdc?
CHECK VOLTAGE AT A1U7-3 FOR 6.3 ± 0.2 Vdc 9
IS VOLTAGE CORRECT?
IS AVANTEK OSCILLATOR Y1 USED?
NORMAL OPERATION
CHECK A1U7
LEGEND
TEST ACTION
TEST STEP NO.
SYMPTOM DECISION POINT
SEQUENCE IDENTIFICATION
ON PAGE
OFF PAGE
CORRECTIVE ACTION

Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 2)

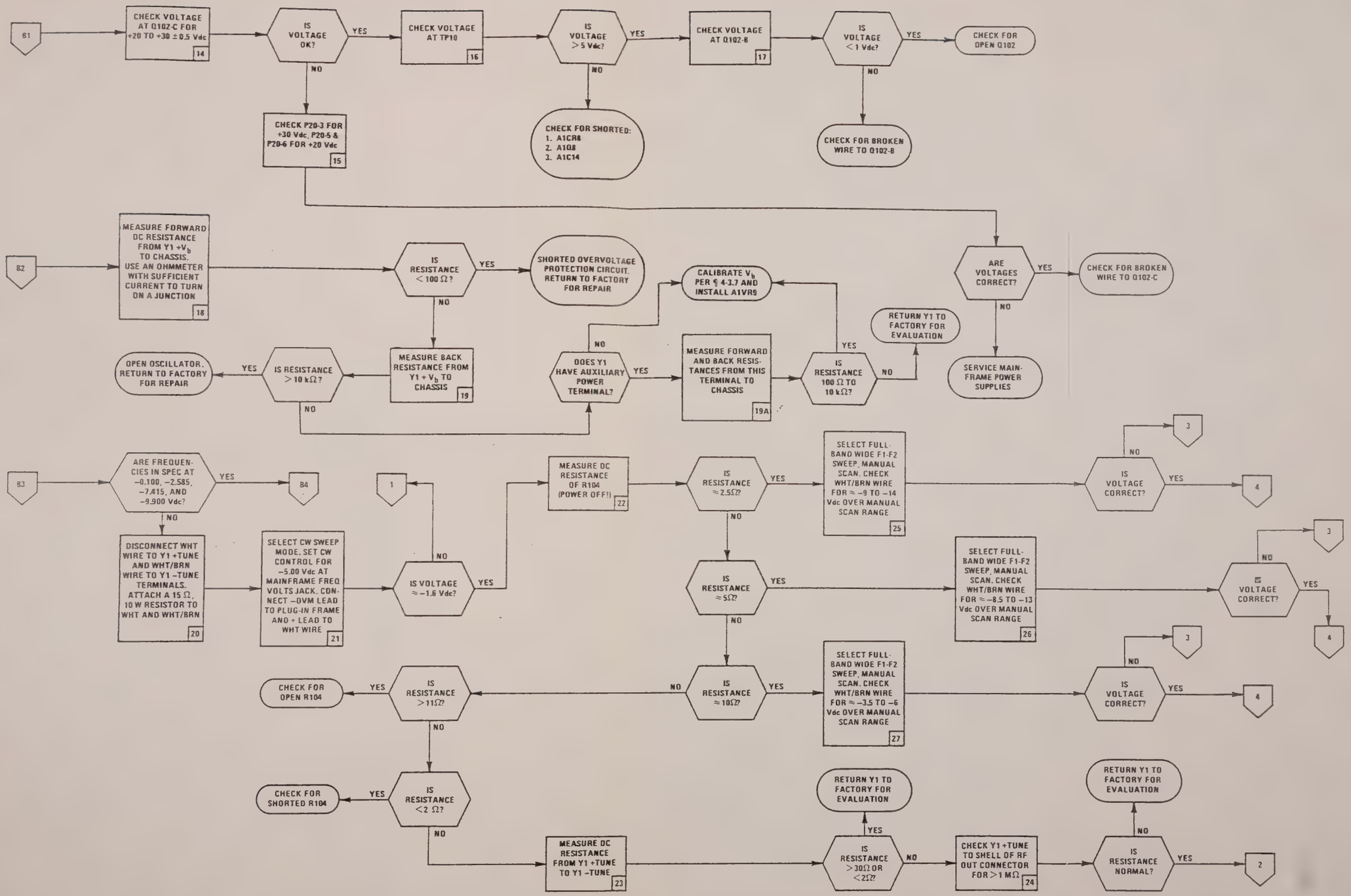


Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 3)

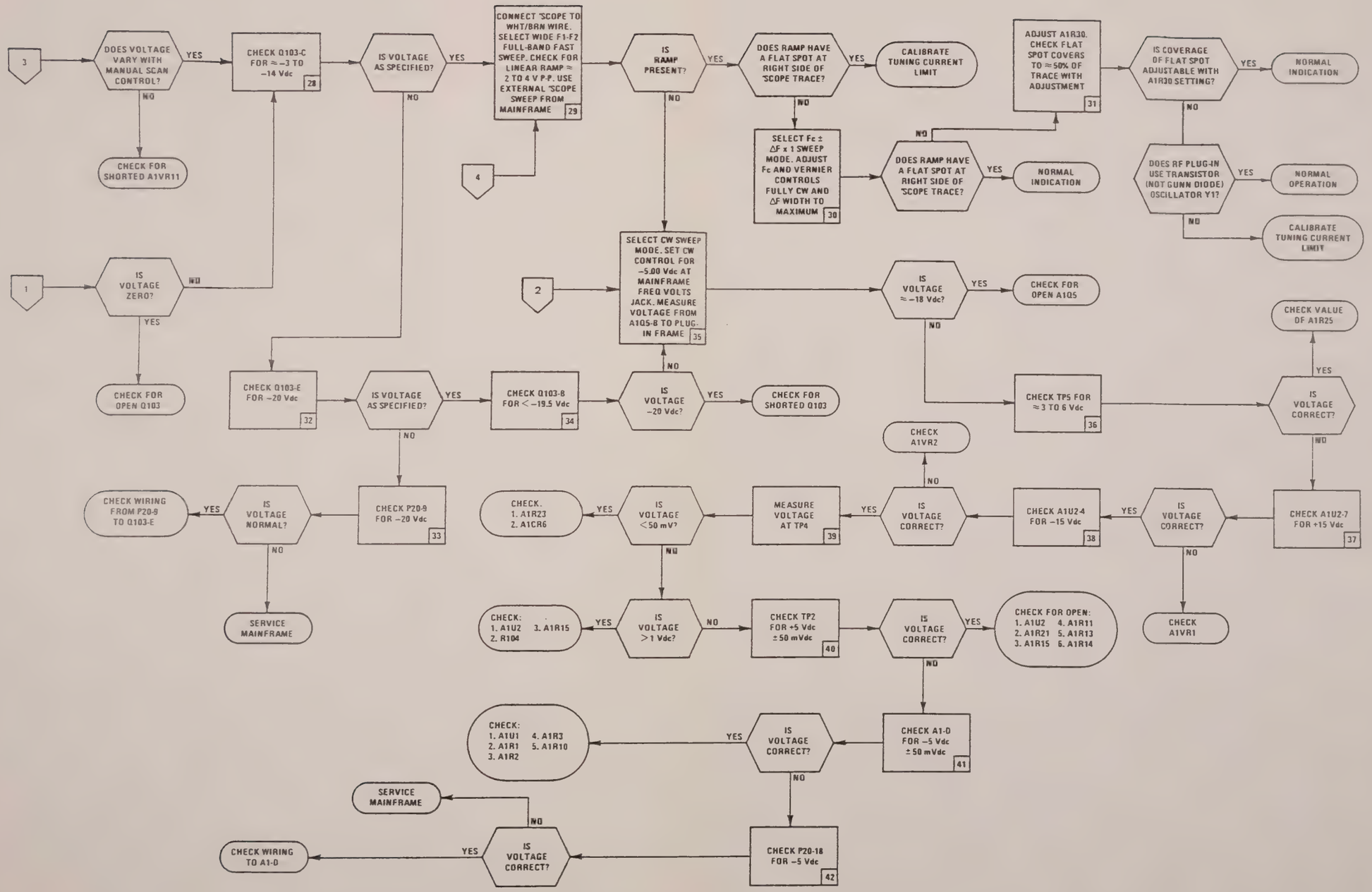


Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 4)

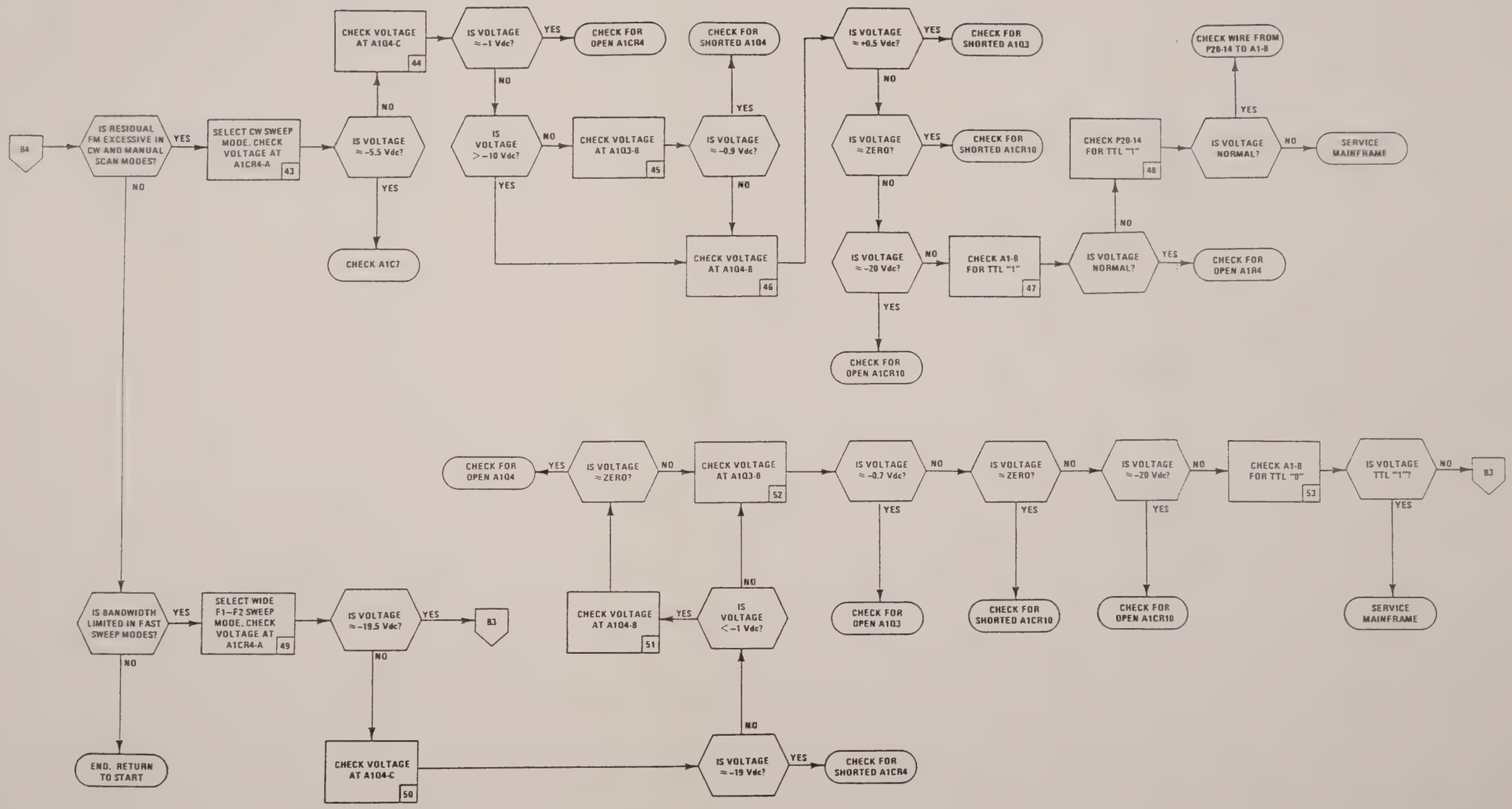


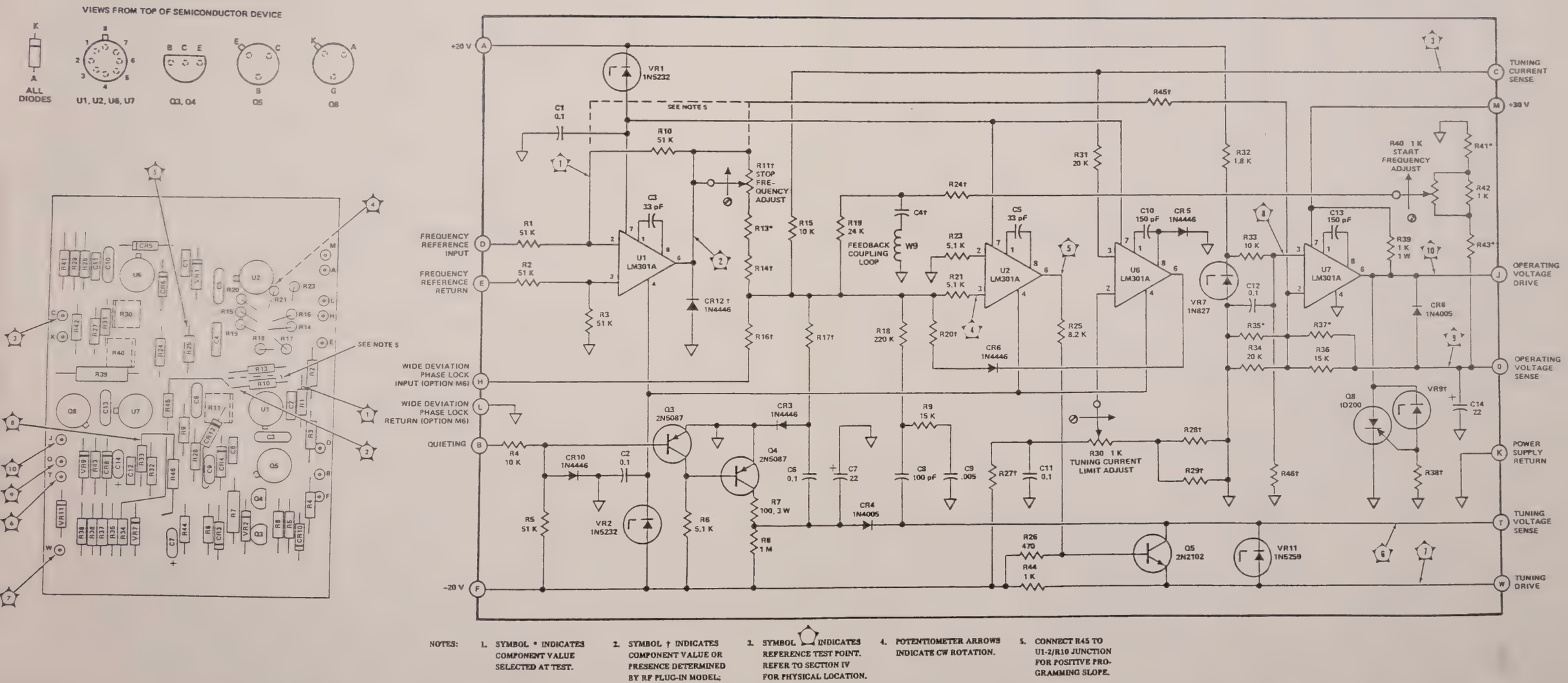
Figure 8-2. Oscillator Driver A1 Troubleshooting Diagram (Sheet 5)

Table 8-2. Oscillator Driver Assembly A1 Replaceable Parts List

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
8-3	A1	B			01220	BOARD ASSY — OSCILLATOR DRIVER Consisting of:
	A1C1		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C2		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C3		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C4	B				CAPACITOR
	A1C5		100175	DM15ED330J0	72136	CAPACITOR, Mica, 33 pF ±5%, 500 V
	A1C6		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C7		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF ±10%, 25 V
	A1C8		100173	DM15FD101J0	72136	CAPACITOR, Mica, 100 pF ±5%, 500 V
	A1C9		107293	TG-D-50	56289	CAPACITOR, Ceramic, .005 μF ±20%, 100 V
	A1C10		100220	DM15FD151J0	72136	CAPACITOR, Mica, 150 pF ±5%, 500 V
	A1C11		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C12		104105	8131100W5R0104K	72982	CAPACITOR, Ceramic, 0.1 μF ±10%, 100 V
	A1C13		100219	DM15FD151J0	72136	CAPACITOR, Mica, 150 pF ±5%, 500 V
	A1C14		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF ±10%, 25 V
	A1CR1					Not used
	A1CR2					Not used
	A1CR3		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR4		105531	1N4005	04713	DIODE, Silicon, 1 A
	A1CR5		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR6		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR7					Not used
	A1CR8		105531	1N4005	04713	DIODE, Silicon, 1 A
	A1CR9					Not used
	A1CR10		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A1CR11					Not used
	A1CR12	B				DIODE
	A1Q1					Not used
	A1Q2					Not used
	A1Q3		105673	2N5087	04713	TRANSISTOR, PNP Silicon, TO-92
	A1Q4		105673	2N5087	04713	TRANSISTOR, PNP Silicon, TO-92
	A1Q5		105652	2N2102	04713	TRANSISTOR, NPN Silicon, TO-5
	A1Q6					Not used
	A1Q7					Not used
	A1Q8		105660	ID200	12969	RECTIFIER, Silicon-Controlled, TO-5
	A1R1		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R2		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R3		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R4		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R5		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R6		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R7		105416	RW69V101	01686	RESISTOR, Wirewound, 100 Ω ±5%, 3 W
	A1R8		104972	RC07GF105K	01121	RESISTOR, Carbon, 1 MΩ ±10%, 1/4 W
	A1R9		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A1R10		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A1R11	B				RESISTOR, Variable (Stop Frequency Adjust)
	A1R12					Not used
	A1R13	T				RESISTOR, Value Selected at Test
	A1R14	B				RESISTOR
	A1R15		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R16	B				RESISTOR
	A1R17	B				RESISTOR
	A1R18		104963	RC07GF224K	01221	RESISTOR, Carbon, 220 kΩ ±10%, 1/4 W
	A1R19		104870	RL07S243G	24546	RESISTOR, Metal Film, 24 kΩ ±2%, 1/4 W
	A1R20	B				RESISTOR
	A1R21		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R22					Not used
	A1R23		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A1R24	B				RESISTOR
	A1R25		104859	RL07S822G	24546	RESISTOR, Metal Film, 8200 Ω ±2%, 1/4 W
	A1R26		104829	RL07S471G	24546	RESISTOR, Metal Film, 470 Ω ±2%, 1/4 W
	A1R27	B				RESISTOR
	A1R28	B				RESISTOR
	A1R29	B				RESISTOR
	A1R30		105490	3305P-1-102	30294	RESISTOR, Variable, 1000 Ω (Tuning Current Limit Adjust)
	A1R31		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R32		104843	RL07S182G	24546	RESISTOR, Metal Film, 1800 Ω ±2%, 1/4 W

Table 8-2. Oscillator Driver Assembly A1 Replaceable Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A1R33		104681	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A1R34		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R35	T				RESISTOR, Value Selected at Test
	A1R36		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A1R37	T				RESISTOR, Value Selected at Test
	A1R38	B				RESISTOR
	A1R39		105006	RC32GF102K	01121	RESISTOR, Carbon, 1000 Ω ±10%, 1 W
	A1R40		105490	3305P-1-102	80294	RESISTOR, Variable, 1000 Ω (Start Frequency Adjust)
	A1R41	T				RESISTOR, Value Selected at Test
	A1R42		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A1R43	T				RESISTOR, Value Selected at Test
	A1R44		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A1R45	B				RESISTOR
	A1R46	B				RESISTOR
	A1U1		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U2		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U3					Not used
	A1U4					Not used
	A1U5					Not used
	A1U6		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1U7		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A1VR1		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A1VR2		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A1VR3					Not used
	A1VR4					Not used
	A1VR5					Not used
	A1VR6					Not used
	A1VR7		100386	1N827	99942	DIODE, Reference, 6.2 V ±.001%/°C
	A1VR8					Not used
	A1VR9	B				DIODE, Zener
	A1VR10					Not used
	A1VR11		105597	1N5259	04713	DIODE, Zener, 39 V ±10%, 1/2 W
			105619	BHS-5-TO5	71002	PAD, Transistor
			936219		01220	BOARD, Printed Circuit



NOTES:

1. SYMBOL * INDICATES COMPONENT VALUE SELECTED AT TEST.
2. SYMBOL † INDICATES COMPONENT VALUE OR PRESENCE DETERMINED BY RF PLUG-IN MODEL; REFER TO TABLE 8-2.
3. SYMBOL ⬠ INDICATES REFERENCE TEST POINT. REFER TO SECTION IV FOR PHYSICAL LOCATION.
4. POTENTIOMETER ARROWS INDICATE CW ROTATION.
5. CONNECT R45 TO U1-2/R10 JUNCTION FOR POSITIVE PROGRAMMING SLOPE.

Figure 8-3. Oscillator Driver A1 Parts Location/Schematic Diagram

SECTION IX

LEVELER/AMPLITUDE MODULATOR

9-1. GENERAL

This section contains circuit theory, trouble isolation information, a replaceable parts list, and a schematic diagram with parts location and test point information for Leveler/Amplitude Modulator Printed Circuit Board Assembly A2 and Power Meter Leveling Printed Circuit Board Assembly A3. Overall plug-in and microwave component operating theory for the RF plug-in in which A2 is installed may be found in Section VI, with the plug-in chassis interconnect wiring diagram and parts list in Section VII.

9-2. THEORY OF OPERATION

The output amplitude of the RF plug-in is controlled by modulator AT1; the general operating principles of this device were described in Section VI. Drive for AT1 is provided by A2.

The Leveler circuits integrate several inputs into drive for AT1:

1. Output power control from front-panel RF LEVEL potentiometer R5
2. 1-kHz square-wave modulation from the generator on A2
3. External amplitude modulation signals coupled through the mainframe
4. Sweep retrace blanking from the mainframe
5. Leveling feedback from an external crystal detector
6. Leveling feedback from an RF power meter (Options M7 and M7A)

The output drive to the modulator is determined by the total current from all input sources flowing into the summing junction of operational amplifier A2U4. If the RF plug-in is equipped with Option M3 or M3A (Fast AM), the amplitude control signal is coupled directly to modulator AT1, bypassing all circuitry on A2.

9-2.1 Drive Levels

A modulator drive input of 20 to 50 milliamperes (refer to Table 1-1) will turn the shunt PIN diodes completely on to fully attenuate the signal from the oscillator. A zero drive level to the PIN diodes allows the RF input to pass with minimum attenuation of about two decibels. The voltage output at A2-S ranges from about 1.2 volts negative for minimum attenuation to about six volts positive for maximum attenuation.

9-2.2 Operating Modes

Two operating modes are available in most RF plug-ins with YIG-tuned oscillators: leveling off and external leveling. Some plug-ins may be fitted with an internal directional detector (option M2). Such units have a three-position front panel LEVELER switch with three modes: leveling off, external leveling and internal leveling. A (generally undesired) fourth mode can occur if the leveling feedback

loop is broken, usually by a cable defect or operator selection of the external leveling mode when no external leveling devices are connected. In this mode there is no control of the output amplitude; it will be either fully on or fully off.

Units equipped with Option M3 or Option M3A cannot be operated in a leveled mode and a fast AM mode simultaneously.

Units equipped with Option M7 or Option M7A are leveled with the "recorder" output of a microwave power meter through the amplifier circuits of A2.

9.2.2.1 LEVELING OFF MODE. The simplest amplitude control configuration exists when the LEVELER switch is set to OFF. The amplitude control circuits are in an open loop configuration in leveling off mode; if there are no marker, blanking, or external AM inputs, and if the 1 KHZ switch is set to OFF, then the only inputs to the summing junction of A2U4 come from RF LEVEL control R5 through A2R4 and from terminal J of A2 through R3 and A2R3.

In the unleveled mode, offset current flows from the minus 20 volt supply through A2R16, R3, and A2R3 to provide a negative bias. Current also flows from the plus 20 volt supply through A2R15 and RF LEVEL control R5. A current determined by the potentiometer setting is fed to the summing junction through A2R4.

9-2.2.2 FAULT MODE. It was previously mentioned that an undefined leveling mode could occur if the LEVELER switch was set to EXT and no negative feedback input was connected. An examination of this mode demonstrates the action of the modulator driver circuits.

Setting switch S11 to EXT short circuits the off-level offset voltage from terminal A2-J directly to ground. With only a positive input from R5 through A2-H connected to the summing junction, A2U4 acts less as a current integrator than as a comparator. When the voltage at the inverting summing junction of A2U4 exceeds that at the non-inverting summing junction, the output changes state. The positive input causes a stiff negative output from A2U4 to drive the base of transistor A2Q5. This turns off the NPN transistor. Modulator drive comes from the minus 20 volt supply through voltage divider A2R35/A2R36.

The negative voltage input drives modulator AT1 to its minimum attenuation, allowing the maximum available oscillator output to be coupled to the RF OUT connector. Negative voltage at this junction also turns on switch A2CR13 and places a feedback capacitor (A2C8) across the modulator drive amplifier to eliminate spurious oscillation.

The negative output amplitude is limited to minus 1.2 volts by diode CR10 and Zener diode VR8 (acting as a conventional diode) in series across the modulator drive amplifier. In addition to the modulator protection afforded by the excursion limiter, which holds the maximum output to plus 6.2 or minus 1.2 volts, voltage limiter diodes A2CR11 and A2CR12 prevent the summing junction voltage from exceeding plus or minus 600 millivolts.

9-2.2.3 EXTERNAL LEVELING MODE. If a negative leveling feedback signal is connected to J7, it will be coupled through the closed contacts of switch S11A and through terminal A2-D to the summing junction. Resistor R3 serves as a load for the input signal in external leveling mode.

In leveled mode, switch section S11C completes a path to ground for resistors A2R13 and A2R14, which then become part of a voltage divider with A2R15. This reduces the maximum voltage available at R5 to a lower value than in unleveled mode.

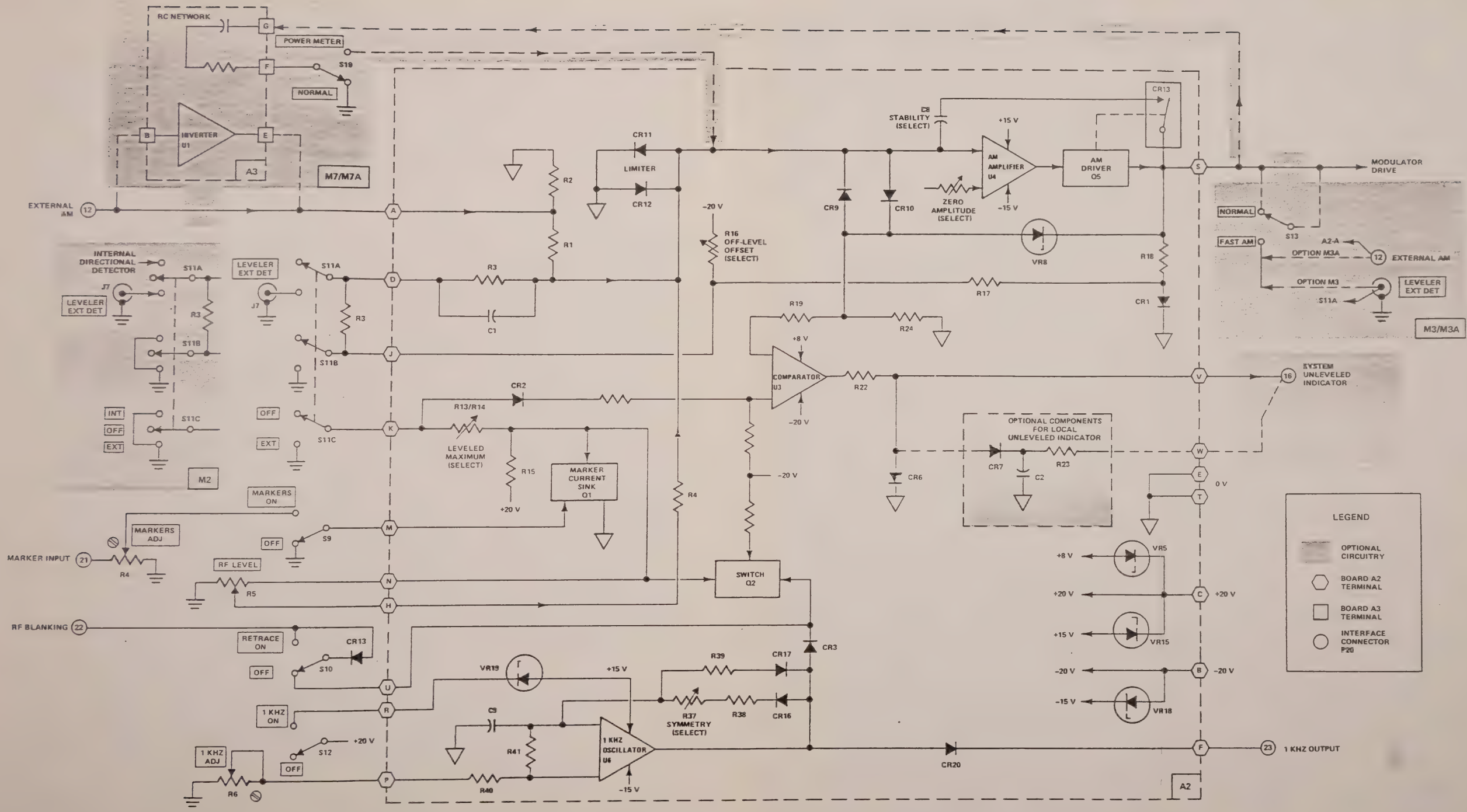


Figure 9-1. Amplitude Modulator Simplified Schematic Diagram

The inputs to the summing junction of A2U4 now consist of negative feedback through A2-D and positive RF LEVEL control from R5. The negative input will tend to make the output of A2Q5 positive, reducing the RF amplitude, while the positive input from R5 will tend to reduce the output of A2Q5 and increase the output amplitude. The ultimate drive level to modulator AT1 is a combination of the feedback from the external detector and the RF LEVEL control setting.

9-2.2.4 MARKERS. When the MARKERS switch is set to ON, a marker pulse from the mainframe is coupled through switch S9 and terminal A2-M to current sink A2Q1, reducing the current available to R5. This causes a brief reduction of the current from R5 (through A2R4) into the summing junction and reduces the RF output amplitude at marker points. The amount of reduction is determined by the marker pulse amplitude as set by MARKERS ADJ control R4.

9-2.2.5 BLANKING. A plus 5 volt sweep retrace (flyback) blanking pulse is coupled through diode CR13 and switch S10 to terminal A2-U when the RETRACE switch is set to OFF. During the retrace period, switch A2Q2 is turned on, causing the voltage at A2-N to become negative; the resulting current flow through R5 and A2R4 causes the summing junction of A2U4 to become negative, the output of A2U4 to become positive, and the output of A2Q5 to become positive enough to drive the PIN diodes in modulator AT1 to maximum attenuation.

The blanking input is coupled through CR13 to isolate it from the 1 kilohertz square wave which is also coupled to the base of A2Q2 through A2CR3 (refer to Paragraph 9-2.2.7).

9-2.2.6 EXTERNAL AM. External AM inputs are connected through terminal A2-A and voltage divider A2R1/A2R2 to the summing junction. As with any input to the summing junction, a negative input will reduce RF output amplitude and a positive input will increase it.

9-2.2.7 1 KHZ GENERATOR. Operational amplifier A2U6 is configured as a voltage comparator to generate a 1 kilohertz square wave. When 1 KHZ switch S12 is set to ON, power is applied to A2U6 through VR19. Assuming the initial output state of A2U6 to be negative, capacitor A2C9 is charged through diode A2CR17 and resistor A2R39. As A2C9 charges, the inverting summing junction will reach a voltage level equal to that at the non-inverting junction, and the output of A2U6 will change output state. A2C9 will begin to charge (in the opposite direction) through A2CR16 and A2R37/A2R38.

When A2U6 changes output state, the polarity at the non-inverting summing junction also changes. When the charge on A2C9 reaches this new level, the output will change state again. This action takes place at the rate of one kilohertz; R6 is part of a voltage divider which allows the comparison voltage at the non-inverting summing junction to be controlled over a narrow range. By altering the level to which A2C9 must be charged in order to effect a change in the output state of A2U6, R6 functions as a frequency control.

9-2.2.8 UNLEVELED INDICATOR. RF plug-ins used in multiband sweep systems are required to provide a remote indication when they are operated in an unleveled mode. Comparator A2U3 changes its output state from about minus eighteen to plus seven volts when there is a difference between the leveling feedback input and a sample of the modulator drive output at A2VR8/A2R24.

When the LEVELER switch is set to OFF, switch section S11C opens the ground path for A2R13/A2R14 and causes current from the plus 20 volt supply to flow through A2CR2 to A2U3 and drive its output to plus seven volts.

Components A2CR7, A2C2, and A2R23 are not used in current production versions of the RF plug-in.

9-2.2.9 OPTION M7. RF plug-ins equipped with Option M7 power meter leveling are equipped with an R-C network to reduce the frequency response of the amplifier formed by A2U4 and A2Q5. The components which comprise the network are mounted on printed circuit assembly A3. The network is switched into the circuit by POWER METER/NORMAL switch S19.

9-2.2.10 OPTION M7A. In addition to the R-C network described in Paragraph 9-2.2.9, printed circuit assembly A3 in RF plug-ins with Option M7A include an operational amplifier configured as a unity-gain inverter. Amplifier A3IC1 inverts the external AM input from a positive-output power meter and offsets it to act as an amplitude-control signal to the external AM input of A2.

9-3. TROUBLE ISOLATION

Figure 9-2 is an aid to trouble isolation in the leveler/amplitude modulator components. This table should be used with the supporting information listed below:

1. The circuit descriptions and simplified schematic diagram in Paragraph 9-2 of this section.

2. Schematic diagram and parts location drawings Figures 9-3 and 9-4 at the end of this section; these drawings include basing diagrams of the multi-lead semiconductor devices used on A2 and A3.

Begin trouble isolation procedures with Figure 5-2 of Section V before attempting trouble isolation to the component level on A2 or A3.

9-4. REPLACEABLE PARTS LIST

Table 9-2 in this section contains a list of replaceable parts for Leveler/Amplitude Modulator Assembly A2. Tables 9-3 and 9-4 lists replaceable parts for Power Meter Leveling Assembly A3. Replaceable parts lists for the chassis assembly are found in Section VII. A replaceable parts list for Oscillator Driver Subassembly A1 is found in Section VIII.

9-4.1 Ordering Replacement Parts

The majority of the electronic parts used in construction of the A2 and A3 board assemblies are standard distributor items, and should be available locally. To order special replacement parts and parts which are not otherwise obtainable, write to Systron-Donner Corporation at the address shown at the front of this manual, or contact your local Scientific Devices office.

Be sure to include the model number and serial number of the unit for which parts are required. Please order by Systron-Donner part number; also include the A2 or A3 reference designator where applicable.

9-4.2 Explanation of Columns

9-4.2.1 FIG. NO. This column references the figure number of the drawings in which the part can be located.

9-4.2.2 REF. DESIG. Electronic parts are listed in sequence by reference designation and may be located on the schematic diagram by this designator.

9-4.2.3 USE CODE. An entry in this column indicates that the part may not be found in all units because it is part of an option, a part replaced when an option is ordered, or an alternate part. The component size or electrical value of a component coded "T" is chosen by test as part of a calibration procedure.

9-4.2.4 SYSTRON-DONNER PART NUMBER. All standard parts manufactured by Systron-Donner or manufactured to Systron-Donner specifications are listed in this column, but not in the *MFR'S PART NUMBER* column. All other purchased parts which have been assigned Systron-Donner part numbers are also listed in this column. These part numbers must be used when ordering parts.

9-4.2.5 MFR'S PART NUMBER. Commercially-available parts not manufactured by Systron-Donner or to Systron-Donner specifications are listed in this column. Insofar as possible, these part numbers are complete. For best results, always include a complete part description as well as the listed manufacturer's part number when ordering replacement parts from manufacturers or distributors.

9-4.2.6 MFR. CODE. The five-digit Federal Manufacturers Codes, as listed in Cataloging Handbooks H4-1 and H4-2, are listed in this column. These codes and corresponding manufacturers are listed in Table 9-1.

9-4.2.7 DESCRIPTION. Descriptions of component parts of subassemblies are indented to indicate the parts comprising each subassembly.

9-5. SCHEMATIC DIAGRAMS

Figure 9-3 is the A2 board parts location drawing and schematic diagram. Figure 9-4 contains the schematic diagrams and parts location drawings for both versions of the A3 board. The schematic diagram for the A1 board is found in Section VIII; the chassis wiring diagram is in Section VII.

Table 9-1. Manufacturer's Codes

CODE	NAME
01121	Allen Bradley Co., Milwaukee, WI 53204
01220	Systron-Donner Corporation,
03508	General Electric Co., Semiconductor Products Dept., Auburn, NY 13021
04713	Motorola, Inc., Semiconductor Products Division, Phoenix, AZ 85036
18714	RCA Solid State Products Division, Findley, OH 45840
24546	Corning Glass Works, Bradford, PA 16701
27014	National Semiconductor Corporation, Santa Clara, CA 95051
31433	Union Carbide Corp., Materials Systems Div., Components Dept., Greenville, SC 29606
56289	Sprague Electric Co., North Adams, MA 01247
63743	Ward Leonard Electric Co., Inc., Subsidiary of Unimax Group, Inc., Mount Vernon, NY 10550
71002	Birnbach Co., Inc., Freeport, LI, NY 11520
72136	Electro-Motive Manufacturing Co., Inc., Subsidiary of International Electronics Corp., Willamantic, CT 06226
91418	Radio Materials Co., Division of P.R. Mallory, Chicago, IL 60646

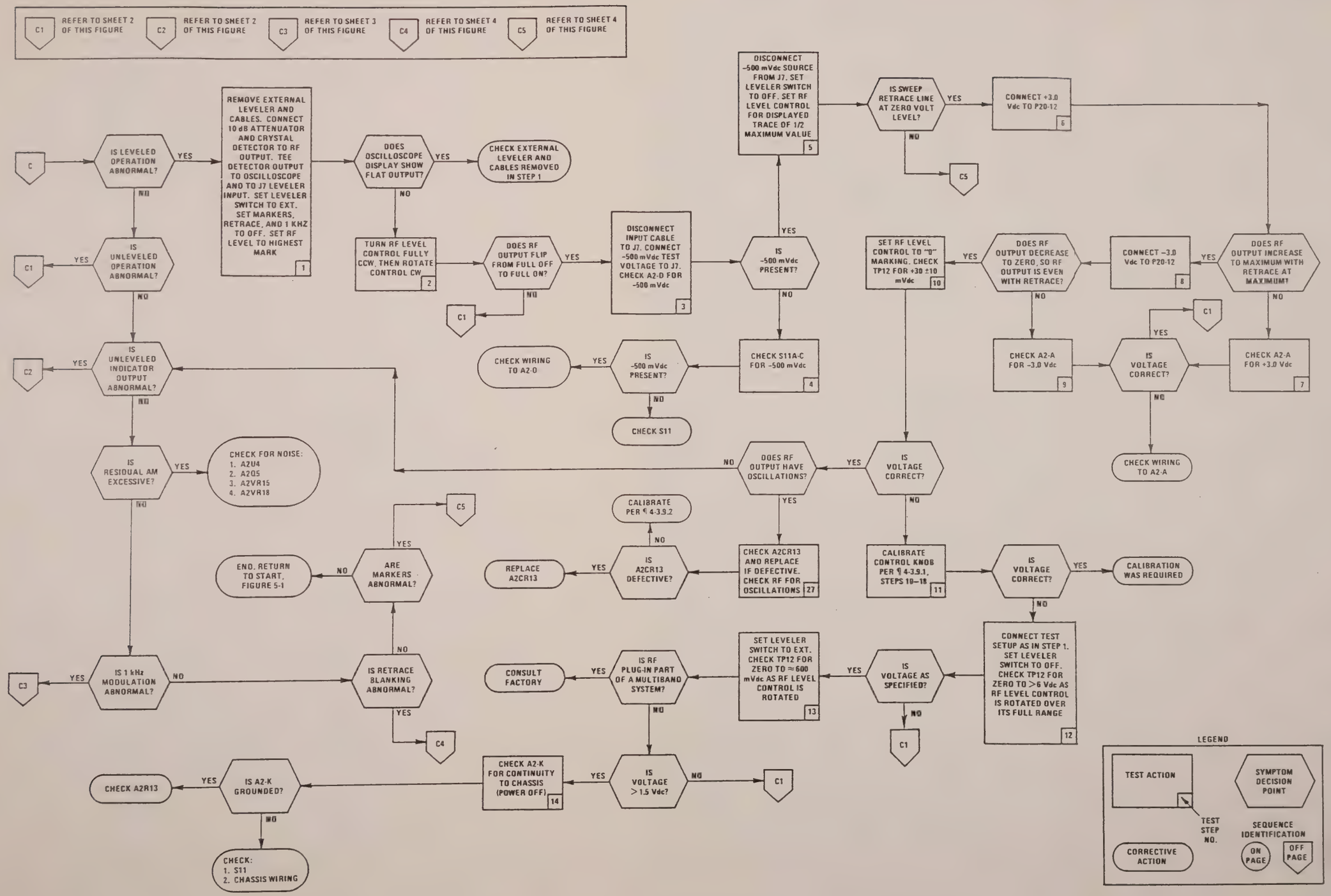

C1 REFER TO SHEET 2 OF THIS FIGURE
C2 REFER TO SHEET 2 OF THIS FIGURE
C3 REFER TO SHEET 3 OF THIS FIGURE
C4 REFER TO SHEET 4 OF THIS FIGURE
C5 REFER TO SHEET 4 OF THIS FIGURE
C
IS LEVELED OPERATION ABNORMAL?
YES
NO
REMOVE EXTERNAL LEVELER AND CABLES. CONNECT 10 dB ATTENUATOR AND CRYSTAL DETECTOR TO RF OUTPUT. TEE DETECTOR OUTPUT TO OSCILLOSCOPE AND TO J7 LEVELER INPUT. SET LEVELER SWITCH TO EXT. SET MARKERS, RETRACE, AND 1 KHZ TO OFF. SET RF LEVEL TO HIGHEST MARK
1
DOES OSCILLOSCOPE DISPLAY SHOW FLAT OUTPUT?
CHECK EXTERNAL LEVELER AND CABLES REMOVED IN STEP 1
TURN RF LEVEL CONTROL FULLY CCW, THEN ROTATE CONTROL CW
2
DOES RF OUTPUT FLIP FROM FULL OFF TO FULL ON?
C1
DISCONNECT INPUT CABLE TO J7. CONNECT -500 mVdc TEST VOLTAGE TO J7. CHECK A2-D FOR -500 mVdc
3
IS -500 mVdc PRESENT?
CHECK S11A-C FOR -500 mVdc
4
IS -500 mVdc PRESENT?
CHECK WIRING TO A2-D
CHECK S11
DISCONNECT -500 mVdc SOURCE FROM J7. SET LEVELER SWITCH TO OFF. SET RF LEVEL CONTROL FOR DISPLAYED TRACE OF 1/2 MAXIMUM VALUE
5
IS SWEEP RETRACE LINE AT ZERO VOLT LEVEL?
C5
CONNECT +3.0 Vdc TO P20-12
6
DOES RF OUTPUT INCREASE TO MAXIMUM WITH RETRACE AT MAXIMUM?
CHECK A2-A FOR +3.0 Vdc
7
CONNECT -3.0 Vdc TO P20-12
8
DOES RF OUTPUT DECREASE TO ZERO, SO RF OUTPUT IS EVEN WITH RETRACE?
CHECK A2-A FOR -3.0 Vdc
9
SET RF LEVEL CONTROL TO "0" MARKING. CHECK TP12 FOR +30 ±10 mVdc
10
IS VOLTAGE CORRECT?
CHECK WIRING TO A2-A
C1
IS VOLTAGE CORRECT?
CALIBRATE CONTROL KNOB PER ¶ 4-3.9.1, STEPS 10–18
11
IS VOLTAGE CORRECT?
CALIBRATION WAS REQUIRED
CONNECT TEST SETUP AS IN STEP 1. SET LEVELER SWITCH TO OFF. CHECK TP12 FOR ZERO TO >6 Vdc AS RF LEVEL CONTROL IS ROTATED OVER ITS FULL RANGE
12
IS VOLTAGE AS SPECIFIED?
C1
SET LEVELER SWITCH TO EXT. CHECK TP12 FOR ZERO TO ≈600 mVdc AS RF LEVEL CONTROL IS ROTATED
13
IS RF PLUG-IN PART OF A MULTIBAND SYSTEM?
CONSULT FACTORY
CHECK A2-K FOR CONTINUITY TO CHASSIS (POWER OFF)
14
IS VOLTAGE > 1.5 Vdc?
C1
DOES RF OUTPUT HAVE OSCILLATIONS?
CHECK A2CR13 AND REPLACE IF DEFECTIVE. CHECK RF FOR OSCILLATIONS
27
IS A2CR13 DEFECTIVE?
REPLACE A2CR13
CALIBRATE PER ¶ 4-3.9.2
NO
YES
DOES RF OUTPUT HAVE OSCILLATIONS?
NO
YES
IS VOLTAGE CORRECT?
NO
YES
C5
ARE MARKERS ABNORMAL?
NO
YES
END. RETURN TO START, FIGURE 5-1
IS RETRACE BLANKING ABNORMAL?
NO
YES
C4
IS 1 kHz MODULATION ABNORMAL?
NO
YES
C3
IS UNLEVELED INDICATOR OUTPUT ABNORMAL?
NO
YES
C2
IS UNLEVELED OPERATION ABNORMAL?
NO
YES
C1
IS RESIDUAL AM EXCESSIVE?
NO
YES
CHECK FOR NOISE:
1. A2U4
2. A2Q5
3. A2VR15
4. A2VR18
IS A2-K GROUNDED?
NO
YES
CHECK A2R13
CHECK:
1. S11
2. CHASSIS WIRING
LEGEND
TEST ACTION
TEST STEP NO.
SYMPTOM DECISION POINT
SEQUENCE IDENTIFICATION
ON PAGE
OFF PAGE
CORRECTIVE ACTION

Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 1)

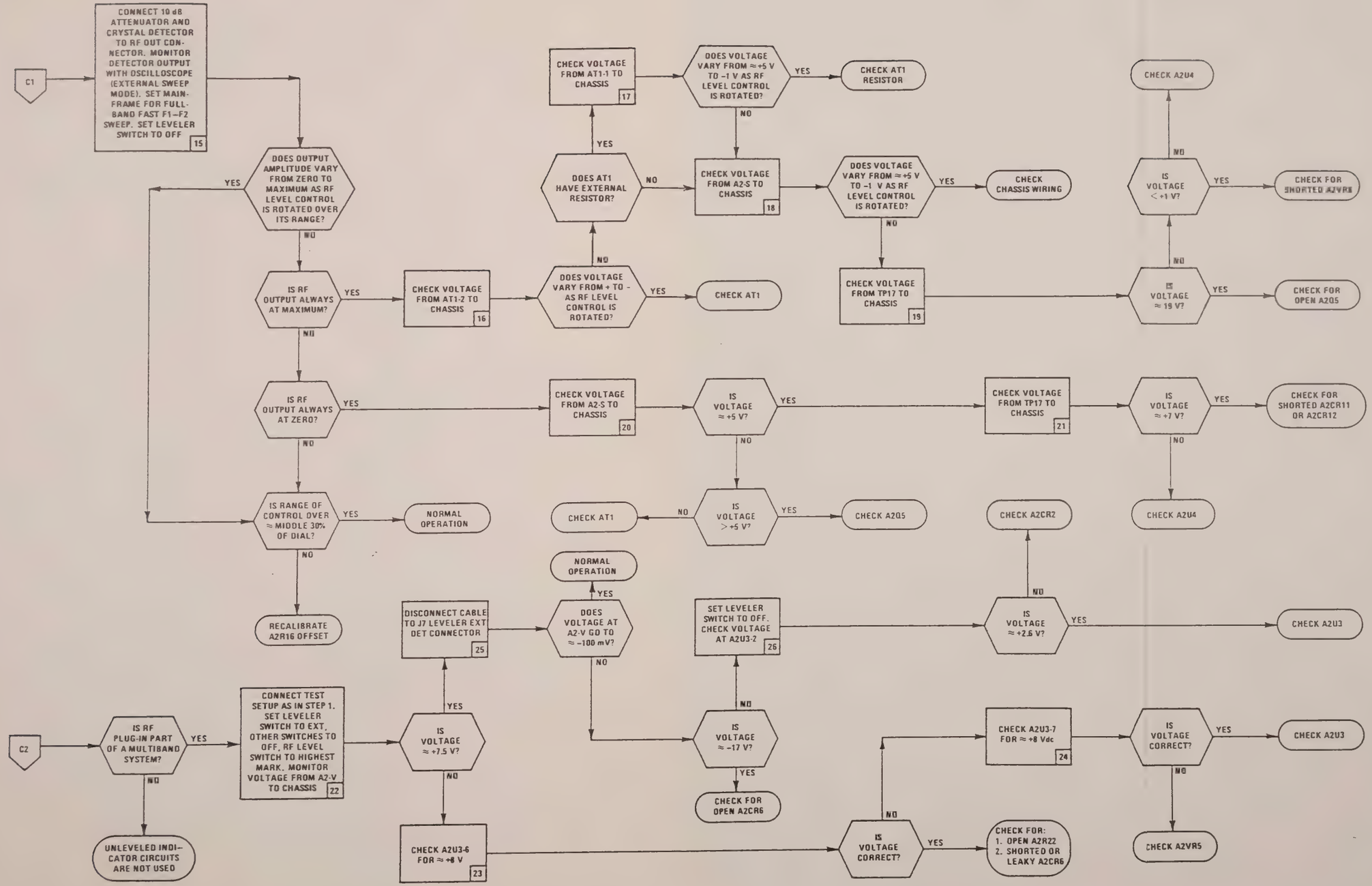

C1
CONNECT 10 dB ATTENUATOR AND CRYSTAL DETECTOR TO RF OUT CONNECTOR. MONITOR DETECTOR OUTPUT WITH OSCILLOSCOPE (EXTERNAL SWEEP MODE). SET MAINFRAME FOR FULL-BAND FAST F1–F2 SWEEP. SET LEVELER SWITCH TO OFF 15
DOES OUTPUT AMPLITUDE VARY FROM ZERO TO MAXIMUM AS RF LEVEL CONTROL IS ROTATED OVER ITS RANGE?
YES
NO
IS RF OUTPUT ALWAYS AT MAXIMUM?
YES
NO
CHECK VOLTAGE FROM AT1-2 TO CHASSIS 16
DOES VOLTAGE VARY FROM + TO - AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK AT1
DOES AT1 HAVE EXTERNAL RESISTOR?
YES
NO
CHECK VOLTAGE FROM AT1-1 TO CHASSIS 17
DOES VOLTAGE VARY FROM ≈ +5 V TO –1 V AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK AT1 RESISTOR
CHECK VOLTAGE FROM A2-S TO CHASSIS 18
DOES VOLTAGE VARY FROM ≈ +5 V TO –1 V AS RF LEVEL CONTROL IS ROTATED?
YES
NO
CHECK CHASSIS WIRING
CHECK VOLTAGE FROM TP17 TO CHASSIS 19
IS VOLTAGE ≈ 19 V?
YES
NO
CHECK FOR OPEN A2Q5
IS VOLTAGE < +1 V?
YES
NO
CHECK FOR SHORTED A2VR8
CHECK A2U4
IS RF OUTPUT ALWAYS AT ZERO?
YES
NO
CHECK VOLTAGE FROM A2-S TO CHASSIS 20
IS VOLTAGE ≈ +5 V?
YES
NO
CHECK VOLTAGE FROM TP17 TO CHASSIS 21
IS VOLTAGE ≈ +7 V?
YES
NO
CHECK FOR SHORTED A2CR11 OR A2CR12
CHECK A2U4
IS RANGE OF CONTROL OVER ≈ MIDDLE 30% OF DIAL?
YES
NO
NORMAL OPERATION
RECALIBRATE A2R16 OFFSET
CHECK AT1
IS VOLTAGE > +5 V?
NO
YES
CHECK A2Q5
CHECK A2CR2
IS VOLTAGE ≈ +2.5 V?
NO
YES
CHECK A2U3
NORMAL OPERATION
DISCONNECT CABLE TO J7 LEVELER EXT DET CONNECTOR 25
DOES VOLTAGE AT A2-V GO TO ≈ –100 mV?
YES
NO
SET LEVELER SWITCH TO OFF. CHECK VOLTAGE AT A2U3-2 26
C2
IS RF PLUG-IN PART OF A MULTIBAND SYSTEM?
YES
NO
UNLEVELED INDICATOR CIRCUITS ARE NOT USED
CONNECT TEST SETUP AS IN STEP 1. SET LEVELER SWITCH TO EXT, OTHER SWITCHES TO OFF, RF LEVEL SWITCH TO HIGHEST MARK. MONITOR VOLTAGE FROM A2-V TO CHASSIS 22
IS VOLTAGE ≈ +7.5 V?
YES
NO
CHECK A2U3-6 FOR ≈ +8 V 23
IS VOLTAGE ≈ –17 V?
YES
NO
CHECK FOR OPEN A2CR6
IS VOLTAGE CORRECT?
YES
NO
CHECK FOR: 1. OPEN A2R22 2. SHORTED OR LEAKY A2CR6
CHECK A2U3-7 FOR ≈ +8 Vdc 24
IS VOLTAGE CORRECT?
YES
NO
CHECK A2U3
CHECK A2VR5

Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 2)

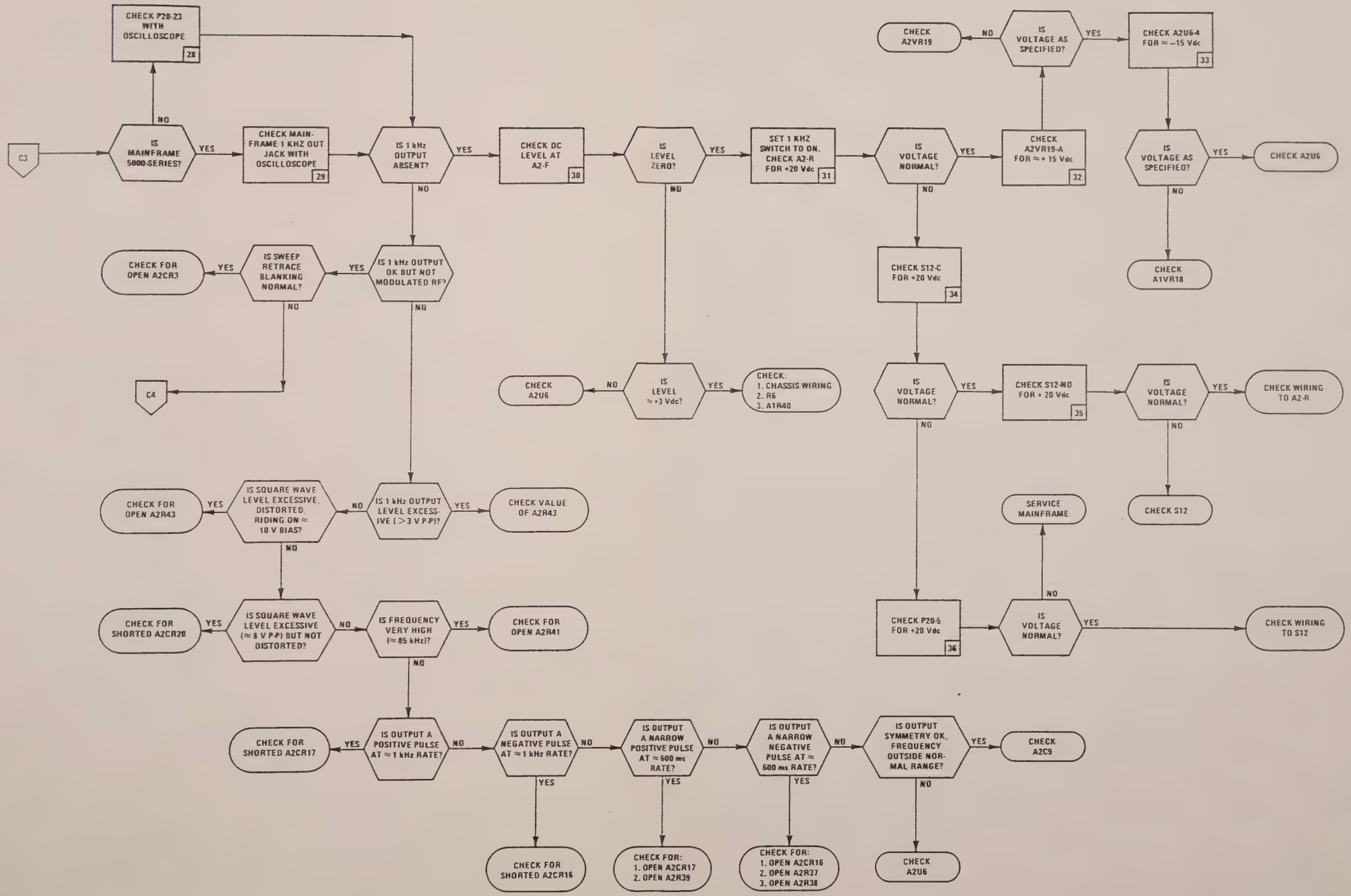


Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 3)

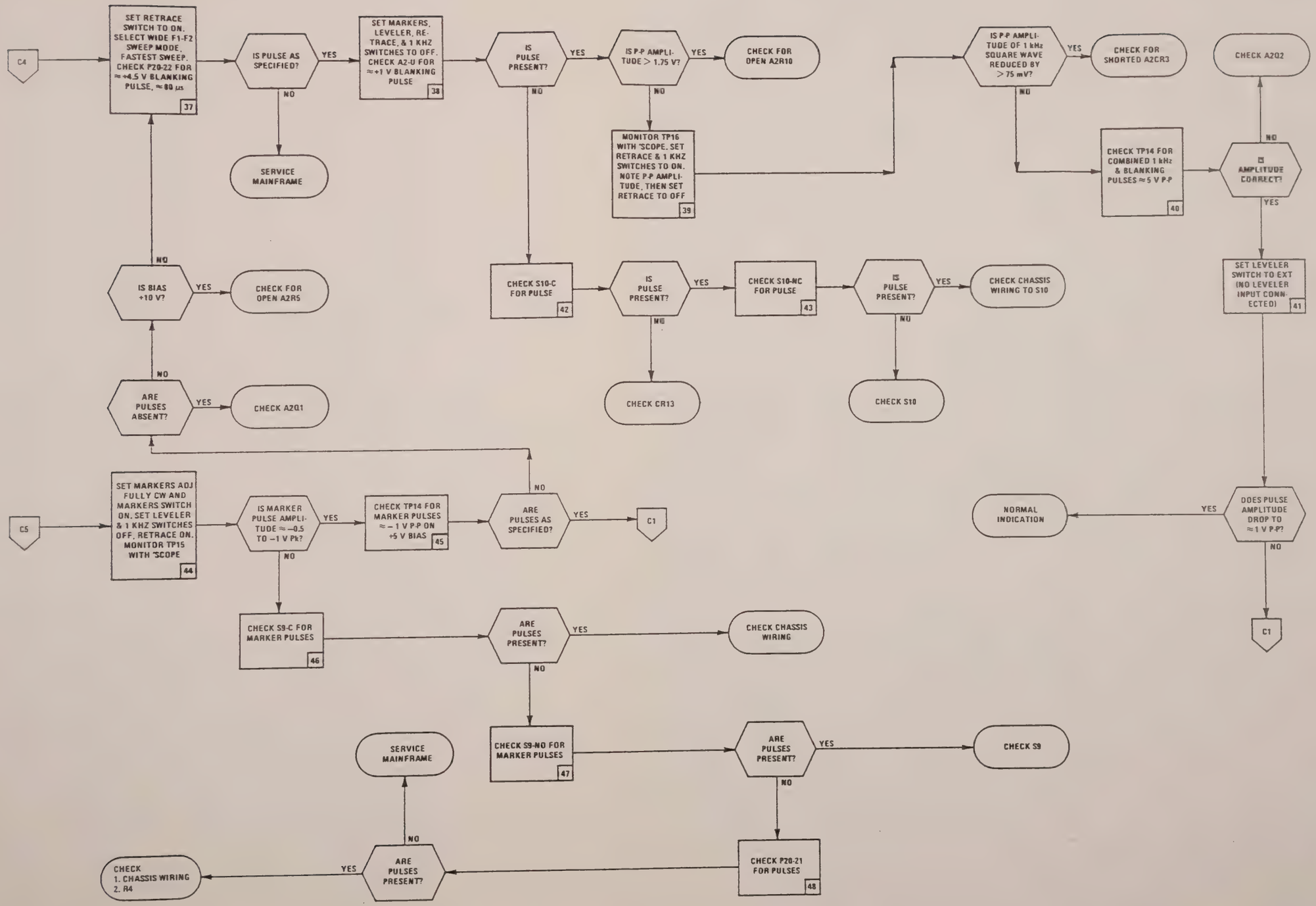


Figure 9-2. Leveler/Amplitude Modulator A2 Troubleshooting Diagram (Sheet 4)

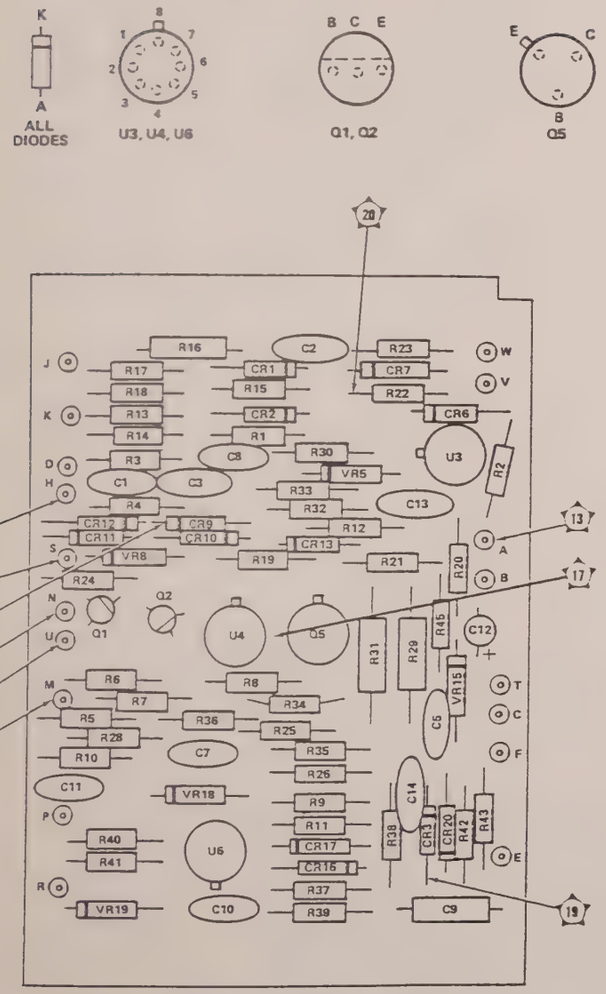
Table 9-2. Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List

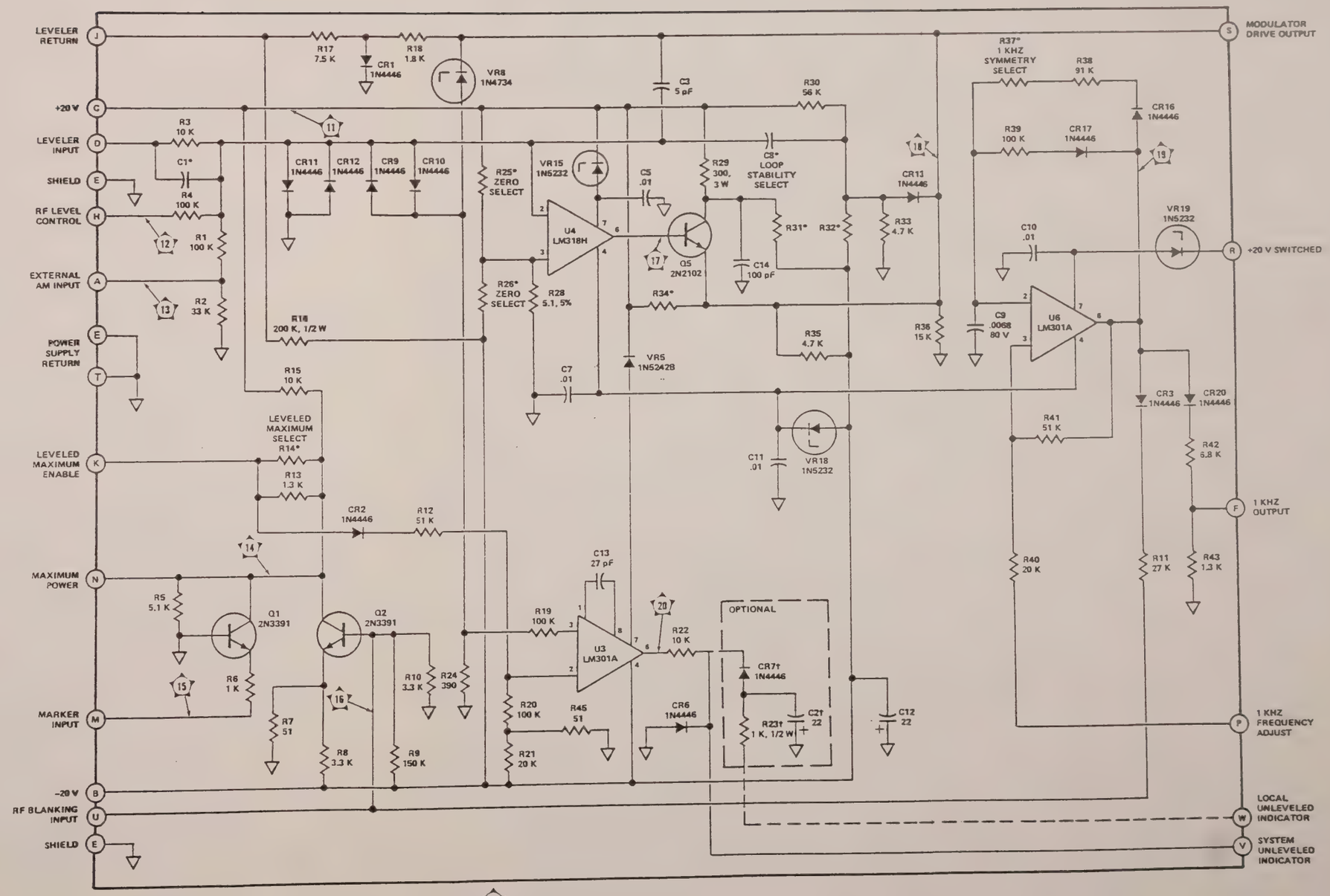
FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A2		950384		01220	BOARD ASSY – LEVELER/A.M. Consisting of:
	A2C1	T				CAPACITOR, Value Selected at Test
	A2C2		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF, 25 V
	A2C3		104136	DM15050K	72136	CAPACITOR, Mica, 5 pF ±5%, 500 V
	A2C4					Not used
	A2C5		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C6					Not used
	A2C7		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C8		100179	DM15ED560J0	72136	CAPACITOR, Mica, 56 pF ±5%, 500 V
	A2C9		100192	192P68292	56289	CAPACITOR, Mylar, 6800 pF ±10%, 80 V
	A2C10		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C11		100103	TA110	91418	CAPACITOR, Ceramic, 0.01 μF +80, –20%, 100 V
	A2C12		104135	T392D226K025AS	31433	CAPACITOR, Tantalum, 22 μF, 25 V
	A2C13		102545	DM15ED270J0	72136	CAPACITOR, Mica, 27 pF ±5%, 500 V
	A2C14		100173	DM15FD101J0	72136	CAPACITOR, Mica, 100 pF ±5%, 500 V
	A2CR1		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR2		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR3		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR4					Not used
	A2CR5					Not used
	A2CR6		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR7		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR8					Not used
	A2CR9		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR10		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR11		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR12		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR13		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR14					Not used
	A2CR15					Not used
	A2CR16		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR17		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2CR18					Not used
	A2CR19					Not used
	A2CR20		105532	1N4446	03508	DIODE, Silicon, 75 PIV
	A2Q1		105654	2N3391	03508	TRANSISTOR, NPN Silicon, R-67
	A2Q2		105654	2N3391	03508	TRANSISTOR, NPN Silicon, R-67
	A2Q3					Not used
	A2Q4					Not used
	A2Q5		105652	2N2102	04713	TRANSISTOR, NPN Silicon, TO-5
	A2R1		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R2		104873	RL07S333G	24546	RESISTOR, Metal Film, 33 kΩ ±2%, 1/4 W
	A2R3		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R4		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R5		104854	RL07S512G	24546	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W
	A2R6		104837	RL07S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W
	A2R7		104806	RL07S510G	24546	RESISTOR, Metal Film, 51 Ω ±2%, 1/4 W
	A2R8		104849	RL07S332G	24546	RESISTOR, Metal Film, 3300 Ω ±2%, 1/4 W
	A2R9		104889	RL07S154G	24546	RESISTOR, Metal Film, 150 kΩ ±2%, 1/4 W
	A2R10		104849	RL07S332G	24546	RESISTOR, Metal Film, 3300 Ω ±2%, 1/4 W
	A2R11		104871	RL07S273G	24546	RESISTOR, Metal Film, 27 kΩ ±2%, 1/4 W
	A2R12		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A2R13		104840	RL07S132G	24546	RESISTOR, Metal Film, 1300 Ω ±2%, 1/4 W
	A2R14	T				RESISTOR, Value Selected at Test
	A2R15		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R16		104905	RL20S204G	24546	RESISTOR, Metal Film, 200 kΩ ±2%, 1/2 W
	A2R17		104858	RL07S752G	24546	RESISTOR, Metal Film, 7500 Ω ±2%, 1/4 W
	A2R18		104843	RL07S182G	24546	RESISTOR, Metal Film, 1800 Ω ±2%, 1/4 W
	A2R19		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R20		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R21		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A2R22		104861	RL07S103G	24546	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W
	A2R23		104901	RL20S102G	24546	RESISTOR, Metal Film, 1000 Ω ±2%, 1/2 W
	A2R24		104827	RL07S391G	24546	RESISTOR, Metal Film, 390 Ω ±2%, 1/4 W
	A2R25	T				RESISTOR, Value Selected at Test
	A2R26	T				RESISTOR, Value Selected at Test
	A2R27					Not used
	A2R28		104923	RC07GF5R1J	01121	RESISTOR, Carbon, 5.1 Ω ±5%, 1/4 W

Table 9-2. Leveler/Amplitude Modulator Assembly A2 Replaceable Parts List (Continued)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
	A2R29		105421	3X300	63743	RESISTOR, Wirewound, 300 Ω ±5%, 3 W
	A2R30		104879	RL07S563G	24546	RESISTOR, Metal Film, 56 kΩ ±2%, 1/4 W
	A2R31	T				RESISTOR, Value Selected at Test
	A2R32	T				RESISTOR, Value Selected at Test
	A2R33		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A2R34	T				RESISTOR, Value Selected at Test
	A2R35		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A2R36		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A2R37	T				RESISTOR, Value Selected at Test
	A2R38		104884	RL07S913G	24546	RESISTOR, Metal Film, 91 kΩ ±2%, 1/4 W
	A2R39		104885	RL07S104G	24546	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W
	A2R40		104868	RL07S203G	24546	RESISTOR, Metal Film, 20 kΩ ±2%, 1/4 W
	A2R41		104878	RL07S513G	24546	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4 W
	A2R42		104857	RL07S682G	24546	RESISTOR, Metal Film, 6800 Ω ±2%, 1/4 W
	A2R43		104840	RL07S132G	24546	RESISTOR, Metal Film, 1300 kΩ ±2%, 1/4 W
	A2R44					Not used
	A2R45		104806	RL07S510G	24546	RESISTOR, Metal Film, 51 Ω ±2%, 1/4 W
	A2U1					Not used
	A2U2					Not used
	A2U3		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A2U4		105609	LM318H	27014	INTEGRATED CIRCUIT, Operational Amplifier
	A2U5					Not used
	A2U6		025745	LM301AH	27014	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
	A2VR1					Not used
	A2VR2					Not used
	A2VR3					Not used
	A2VR4					Not used
	A2VR5		105578	1N5242B	04713	DIODE, Zener, 12 V ±5%, 1/2 W
	A2VR6					Not used
	A2VR7					Not used
	A2VR8		100421	1N4734A	04713	DIODE, Zener, 5.6 V ±10%, 1 W
	A2VR9					Not used
	A2VR10					Not used
	A2VR11					Not used
	A2VR12					Not used
	A2VR13					Not used
	A2VR14					Not used
	A2VR15		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A2VR16					Not used
	A2VR17					Not used
	A2VR18		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A2VR19		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
			105619	BHS-5-TO5	71002	PAD, Transistor
			936190		01220	BOARD, Printed Circuit

VIEWS FROM TOP OF SEMICONDUCTOR DEVICE





NOTES:

1. SYMBOL * INDICATES COMPONENT VALUE SELECTED AT TEST.
2. SYMBOL † INDICATES COMPONENTS NOT USED IN CURRENT PRODUCTION VERSIONS.
3. SYMBOL ⬠ INDICATES REFERENCE TEST POINT. REFER TO SECTION IV FOR PHYSICAL LOCATION.

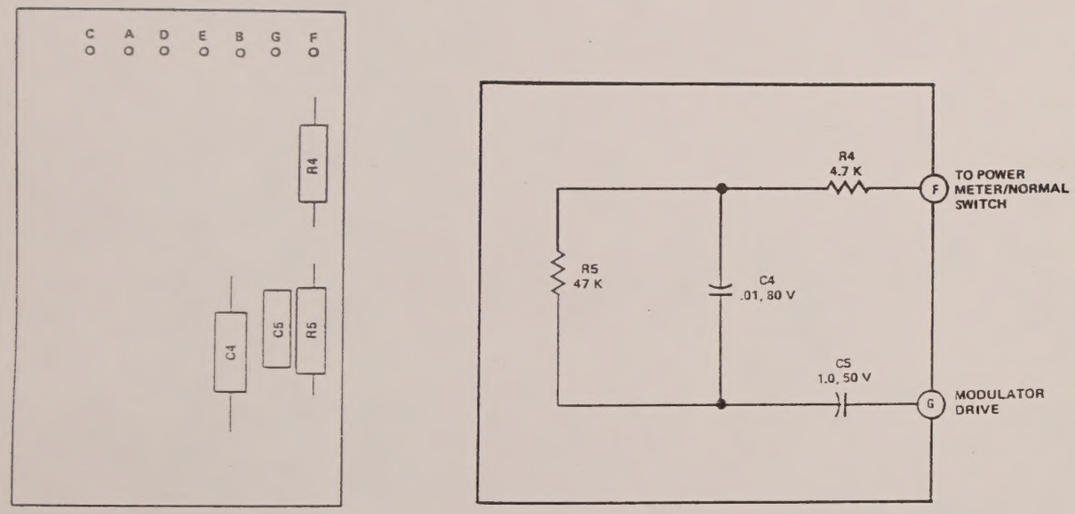
Figure 9-3. Leveler/Amplitude Modulator A2 Parts Location/Schematic Diagram

Table 9-3. Power Meter Leveling Assembly A3 (Option M7)

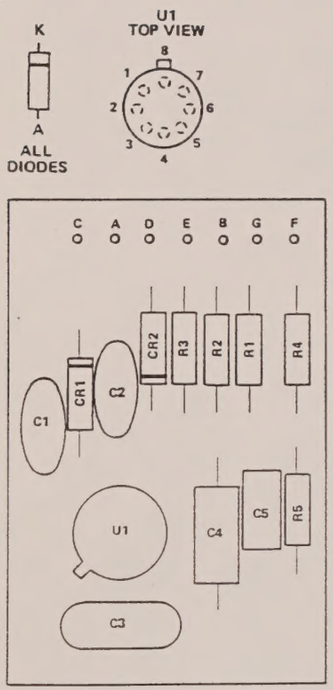
FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
9-4	A3	M7	95060501		01220	BOARD ASSY – POWER METER LEVELING Consisting of:
	A3C1					Not used
	A3C2					Not used
	A3C3					Not used
	A3C4		104147	192P1039R8	56389	CAPACITOR, Mylar, 0.01 μF ±10%, 80 V
	A3C5		107627	3420-050E105M	00656	CAPACITOR, Ceramic, 1.0 μF ±20%, 50 V
	A3R1					Not used
	A3R2					Not used
	A3R3					Not used
	A3R4		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A3R5		104877	RL07S473G	24546	RESISTOR, Metal Film, 47 kΩ ±2%, 1/4 W
			936276		01220	BOARD, Printed Circuit

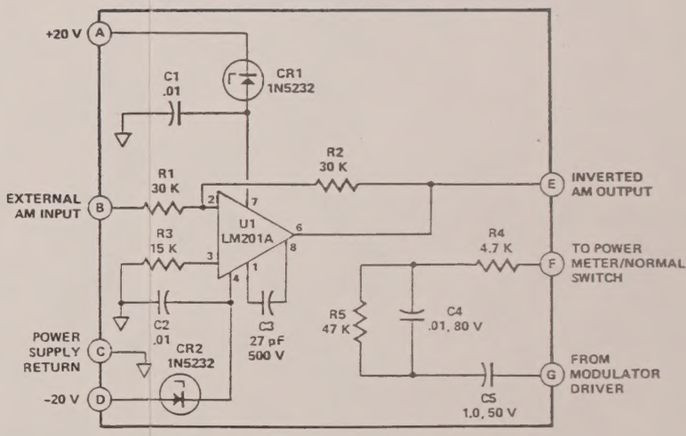
Table 9-4. Power Meter Leveling Assembly A3 (Option M7A)

FIG. NO. / ITEM NO.	REF. DESIG.	USE CODE	SYSTRON-DONNER PART NUMBER	MFR. PART NO.	MFR. CODE	DESCRIPTION
9-4	A3	M7A	95060502		01220	BOARD ASSY – POWER METER LEVELING Consisting of:
	A3C1		150100	TGS10	56280	CAPACITOR, Ceramic, 0.01 μF +80% –20%, 100 V
	A3C2		150100	TGS10	56280	CAPACITOR, Ceramic, 0.01 μF +80% –20%, 100 V
	A3C3		102545	DM15ED270J0	72136	CAPACITOR, Mica, 27 pF ±5%, 500 V
	A3C4		104147	192P1039R8	56389	CAPACITOR, Mylar, 0.01 μF ±10%, 80 V
	A3C5		107627	3420-050E105M	00656	CAPACITOR, Ceramic, 1.0 μF ±20%, 50 V
	A3CR1		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A3CR2		105563	1N5232	04713	DIODE, Zener, 5.6 V ±10%, 1/2 W
	A3R1		104872	RL07S303G	24546	RESISTOR, Metal Film, 30 kΩ ±2%, 1/4 W
	A3R2		104872	RL07S303G	24546	RESISTOR, Metal Film, 30 kΩ ±2%, 1/4 W
	A3R3		104865	RL07S153G	24546	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4 W
	A3R4		104853	RL07S472G	24546	RESISTOR, Metal Film, 4700 Ω ±2%, 1/4 W
	A3R5		104877	RL07S473G	24546	RESISTOR, Metal Film, 47 kΩ ±2%, 1/4 W
	A3U1		105616	LM201AH	04713	INTEGRATED CIRCUIT, Operational Amplifier, TO-5
			936276		01220	BOARD, Printed Circuit



A3 OPTION M7 NEGATIVE POWER METER LEVELING ASSEMBLY 95060501





A3 OPTION M7A POSITIVE POWER METER LEVELING ASSEMBLY 95060502

Figure 9-4. Power Meter Leveler A3 Parts Location/Schematic Diagram

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